STN PUB
NRM
M.P.
No. 3

WHAT TO SEE AND WHERE TO FIND IT

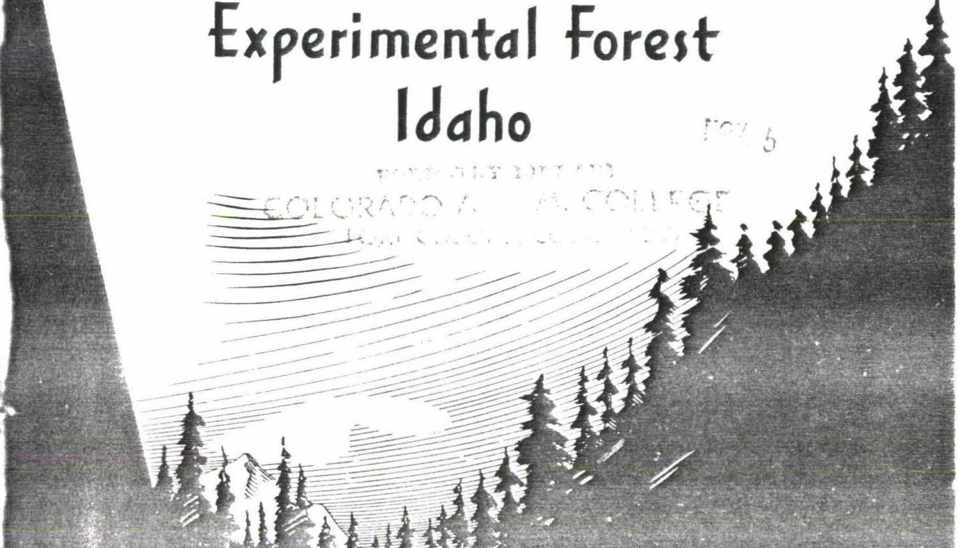
on the Priest River
Experimental Forest
Idaho

LIBRARY COPY
ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

WHAT TO SEE AND WHERE TO FIND IT

on the Priest River Experimental Forest Idaho

NOV 5
COLORADO A [illegible] M COLLEGE



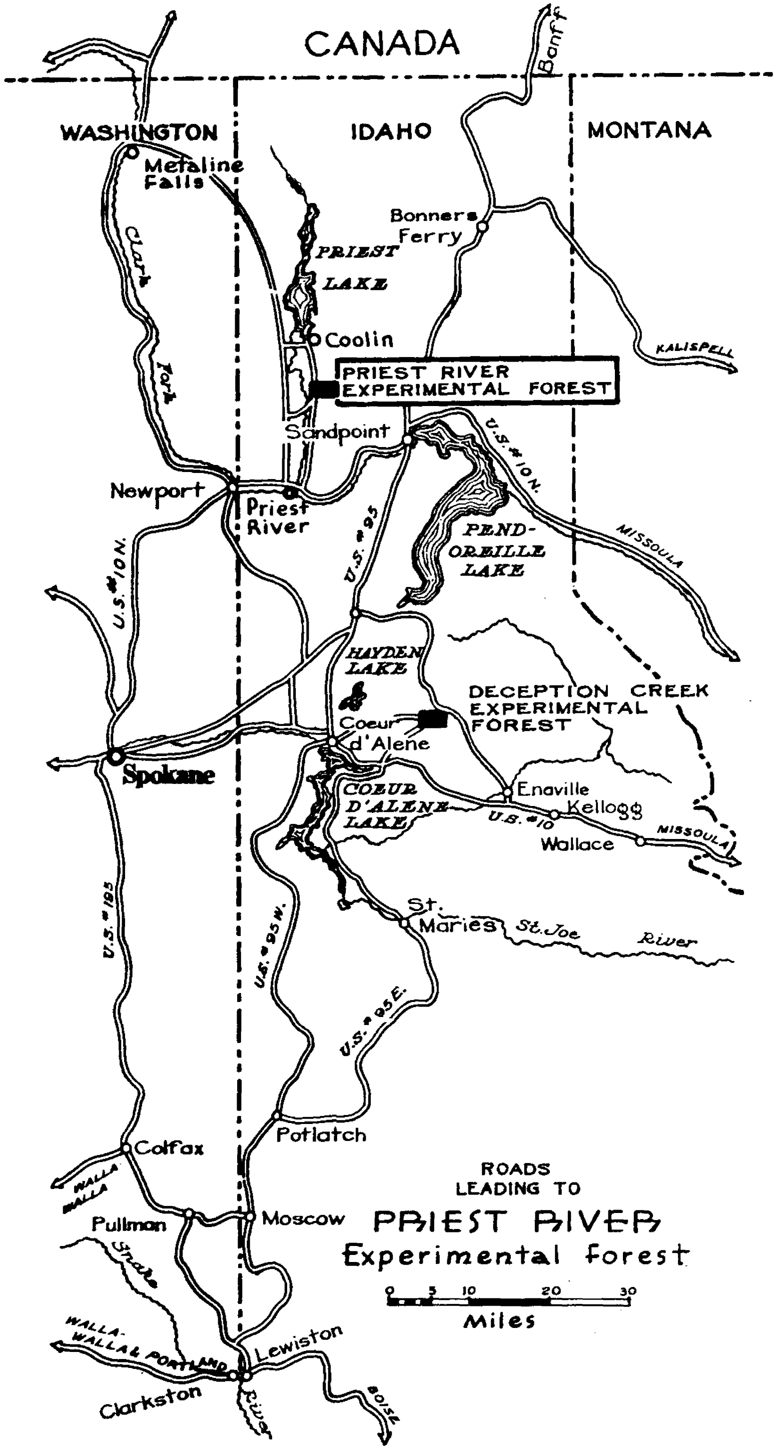
A FIELD RESEARCH CENTER
OF THE NORTHERN
ROCKY MOUNTAIN
FOREST AND RANGE
EXPERIMENT STATION

Mis, Pub #3

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

LIBRARY COPY
ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION


CANADA
WASHINGTON
IDAHO
MONTANA
Banff
Metaline Falls
Clark Fork
PRIEST LAKE
Bonners Ferry
Coolin
KALISPELL
PRIEST RIVER EXPERIMENTAL FOREST
Sandpoint
U.S. #10 N.
Newport
Priest River
U.S. #95
PEND-OREILLE LAKE
MISSOULA
U.S. #10 N.
HAYDEN LAKE
DECEPTION CREEK EXPERIMENTAL FOREST
Coeur d'Alene
Spokane
COEUR D'ALENE LAKE
Enaville
Kellogg
U.S. #10
MISSOULA
Wallace
St. Maries
St. Joe River
U.S. #195
U.S. #95 W.
U.S. #95 E.
Colfax
Potlatch
WALLA WALLA
Pullman
Moscow
Snake
ROADS LEADING TO PRIEST RIVER Experimental Forest
0 5 10 20 30
Miles
WALLA-WALLA & PORTLAND
Lewiston
Clarkston
River
BOISE

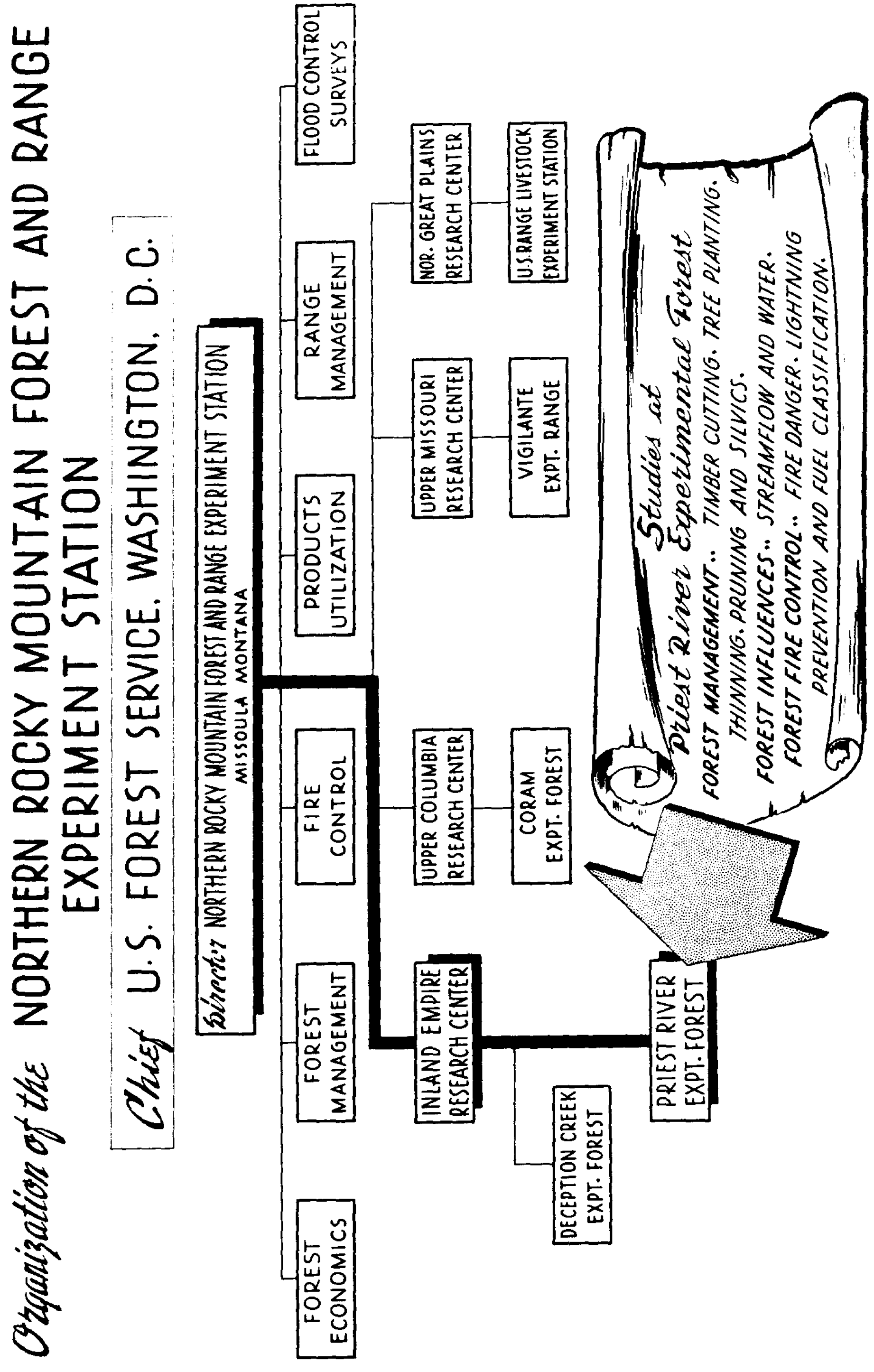
WHAT TO SEE AND WHERE TO FIND IT ON THE PRIEST RIVER EXPERIMENTAL FOREST

By

C. A. Wellner, R. F. Watt, and A. E. Helmers
Northern Rocky Mountain Forest and Range Experiment Station
Miscellaneous Publication No. 3
May 1951

This booklet is intended to help you see and understand research in progress on the Priest River Experimental Forest. It gives information on the purposes, history, methods, and results of each of our main experiments. You may obtain further details on some of the studies from "bulletin board" signs located on the experimental area or from resident personnel. Copies of published information on other experiments are available at the Experimental Forest headquarters or from the Northern Rocky Mountain Forest and Range Experiment Station at 157 South Howard Street, Spokane, Washington, and Missoula, Montana.

The Forest superintendent or other staff members will be glad to show you around. This booklet has been so arranged, however, that with its aid you can find your way without a guide and may see and study the various experimental areas in as much detail as you wish.



Organization of the NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Chief U.S. FOREST SERVICE, WASHINGTON, D.C.
Director NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
MISSOULA MONTANA
FOREST ECONOMICS
FOREST MANAGEMENT
FIRE CONTROL
PRODUCTS UTILIZATION
RANGE MANAGEMENT
FLOOD CONTROL SURVEYS
INLAND EMPIRE RESEARCH CENTER
UPPER COLUMBIA RESEARCH CENTER
UPPER MISSOURI RESEARCH CENTER
NOR. GREAT PLAINS RESEARCH CENTER
DECEPTION CREEK EXPT. FOREST
PRIEST RIVER EXPT. FOREST
CORAM EXPT. FOREST
VIGILANTE EXPT. RANGE
U.S. RANGE LIVESTOCK EXPERIMENT STATION
Studies at Priest River Experimental Forest
FOREST MANAGEMENT.. TIMBER CUTTING. TREE PLANTING.
THINNING. PRUNING AND SILVICS.
FOREST INFLUENCES.. STREAMFLOW AND WATER.
FOREST FIRE CONTROL.. FIRE DANGER. LIGHTNING
PREVENTION AND FUEL CLASSIFICATION.

PURPOSE AND HISTORY OF THE PRIEST RIVER EXPERIMENTAL FOREST

Dedicated to the development of better methods of management and protection of forested lands, the Priest River Experimental Forest is maintained for research and demonstration purposes by the Northern Rocky Mountain Forest and Range Experiment Station of the Forest Service, U. S. Department of Agriculture. The chart on the opposite page shows where the Experimental Forest fits into the United States Forest Service organization. The Experimental Forest is located in the Kaniksu National Forest, 15 miles north by road from Priest River, Idaho.

Fire research, forest management research, and special flood control survey studies are the principal activities on the Experimental Forest at present. The Forest and its facilities are available for research in all phases of forestry and related subjects, and workers from educational and research agencies are welcome to use it for their experiments.

The Priest River Experimental Forest was established in August 1911. In the beginning years, the permanent staff of two men -- D. R. Brewster, Director, assisted for a year by J. V. Hoffman, then by J. A. Larsen -- was occupied mainly with nursery and planting studies, methods of cutting studies, investigations of species requirements, and the large job of constructing buildings and roads. The same lines of investigation continued for the first 10 years, except for nursery and planting studies which were transferred to Savenac Nursery in Montana.

During the decade beginning in 1920, fire research became a major project and received the full attention of one or more staff members. In silviculture, effort was directed chiefly to development of white pine yield and volume tables and to the study of factors controlling natural seeding and establishment of western white pine and associated trees.

The research program was enlarged after 1930. Fire research at Priest River reached an all-time high, with principal emphasis upon evaluation of factors affecting fire danger and rate of spread. Gaging of Benton Creek was started in 1938. Forest management research also expanded, but much of this expansion occurred at the newly established Deception Creek Experimental Forest in the Coeur d'Alene National Forest, Idaho. Between 1933 and 1940, most of the existing roads and buildings were constructed under public works programs, chiefly the Civilian Conservation Corps.

During World War II, most of the research work dropped to a maintenance level. Among postwar activities, flood control survey studies of snow and water runoff have been the most significant.

DESCRIPTION OF THE FOREST

The total area of the Experimental Forest is 6368 acres. Elevation ranges from 2200 feet above sea level at the river on the western edge of the Forest to 5900 feet on Gisborne Mountain at the easternmost extension. Almost all of the tract is forested, with the exception of south slope "balds" on Gisborne Mountain. Principal cover types with their percentage area distribution are:

Western white pine	32
Western larch -- Douglas-fir	17
Douglas-fir	10
Lodgepole pine	7
Ponderosa pine	7
Subalpine	7
Miscellaneous	20

As estimated in 1934, merchantable timber volumes in board feet (Scribner rule) on the Experimental Forest were as follows:

Western white pine (*Pinus monticola*)	12,309,000
Western larch (*Larix occidentalis*)	10,346,000
Douglas-fir (*Pseudostuga taxifolia*)	9,252,000
Grand fir (*Abies grandis*)	1,845,000
Western hemlock (*Tsuga heterophylla*)	3,841,000
Western redcedar (*Thuja plicata*)	6,184,000
Lodgepole pine (*Pinus contorta*)	930,000
Ponderosa pine (*Pinus ponderosa*)	5,334,000
Engelmann spruce (*Picea engelmanni*)	1,975,000
Alpine fir (*Abies lasiocarpa*)	2,082,000
White bark pine (*Pinus albicaulis*)	601,000
Total	54,699,000

About three-fourths of the Forest is covered with timber less than 100 years of age and the other fourth with mature and overmature timber. From 1911 through 1950, a little more than 3 million board feet of timber were cut. Although harvest cuttings are largely experimental, they are conducted as regular logging operations. Stumpage is sold to the highest bidder and logged in accordance with specific cutting plans.

The Kaniksu National Forest provides fire protection, maintains trails and roads, supervises blister rust and insect control, and administers the timber sales on the Experimental Forest.

INVESTIGATIVE PROJECTS

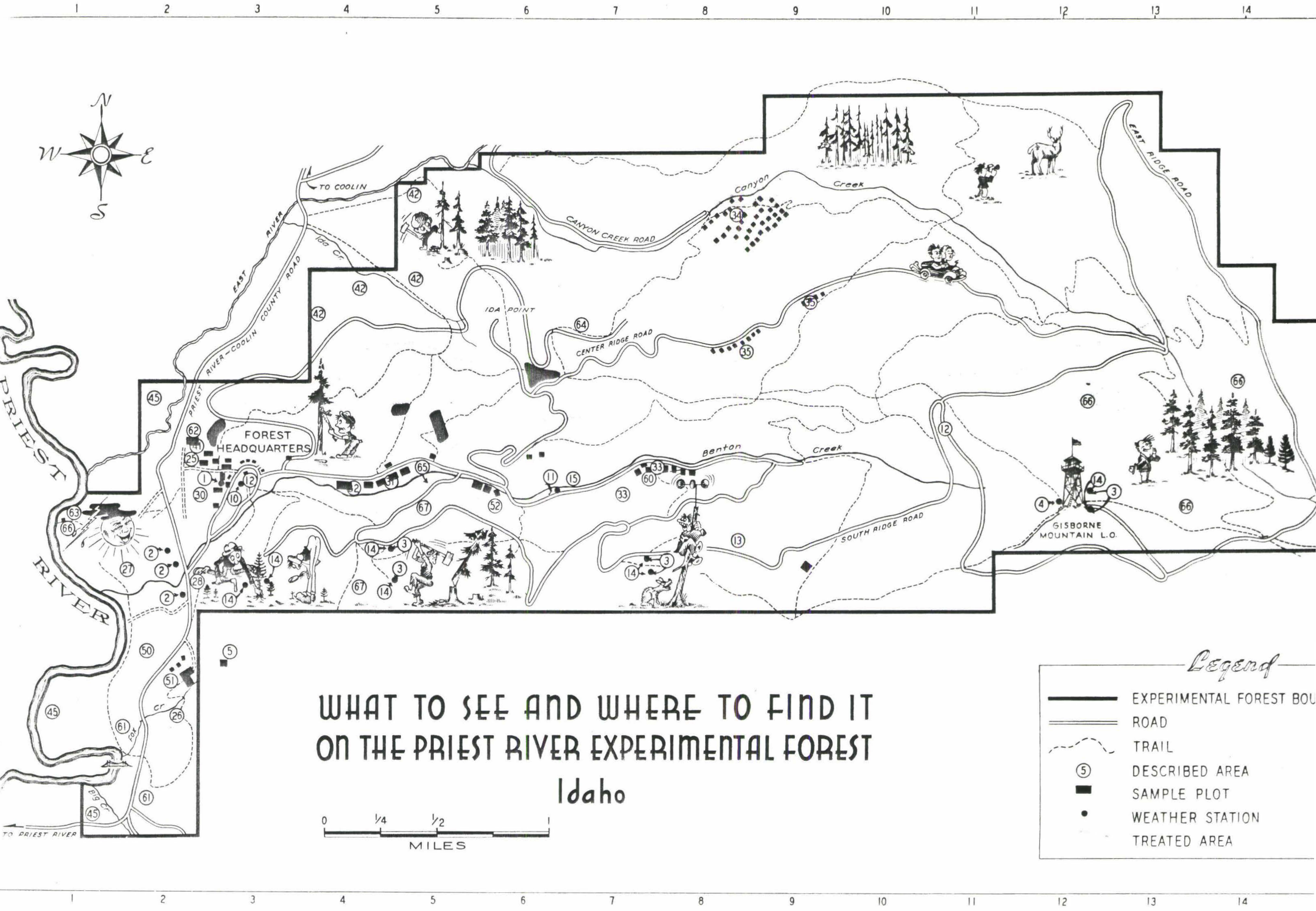
Most of the studies and experiments on the Priest River Experimental Forest are shown by area number on the map opposite Page 6. Facing the map is an index by area number which shows the map location, subject, and page where each area is described.

Subject matter guide to numbered experimental areas:

Subject	Area Number
Forest fire studies	
Fire danger	
Under various forest canopies	2
By altitude and aspect	3
Through forest canopy	1
Effect of vegetation	2, 5
Effect of large logs	2
Gisborne Mountain lookout	4
Lightning control	1
Special flood control survey studies	
Snow studies	
Transect	13
Altitude and aspect	14
Low elevation	2, 25
Benton watershed hydrology	15
Miscellaneous	
Control weather station	10
Cooperative snow courses	12
Benton Creek streamflow gaging station	11
Forest management studies	
Harvest cuttings of mature timber	
Clear cuttings	50, 52
Shelterwood cuttings	2, 52
Intermediate harvest cuttings in immature stands	
Selection thinnings	32, 35
Stand improvement	
Thinnings and improvement cuttings	30, 31, 32, 33, 34, 35
Pruning	41, 42
Defective tree disposal	45
Artificial regeneration	
Planting	25, 26, 27, 28
Genetics	
Racial variation	62
Test of hybrids	68
Arboretum	61
Protection	
Blister rust	65
Pole blight	64
Fire	67
Miscellaneous	
Silvical	2, 51, 63
Growth and yield	51, 60
Natural area	66

INDEX TO NUMBERED AREAS OF MAP ON OPPOSITE PAGE

Area Number	Map Location	Subject	Write-up on Page
		FOREST FIRE STUDIES	7
1	E2	Forest weather tower	9
2	F2	Inflammability stations	11
3	E5, E8, E12	Altitude and aspect stations	13
4	E12	Gisborne Mountain lookout	15
5	G3	Vegetation station	17
		SPECIAL FLOOD CONTROL STUDIES	19
10	E3	Control weather station	21
11	E6	Benton Creek streamflow gaging station	23
12	E3, D11	Cooperative snow courses	25
13	E8	Transect snow studies	27
14	F3, E4, F4, F7, E12	Altitude and aspect snow studies	29
15	E7	Hydrology of Benton Creek watershed	31
		FOREST MANAGEMENT STUDIES	33
2	F2	White pine regeneration	35
25	D2	Brewster plantations	37
26	G2	Marshall plantation	39
27	F2	Lower Benton Creek plantations	41
28	F2	Model plantation	43
30	E2	Larsen thinnings	45
31	E4	1919 thinnings	47
32	E4	Kempff thinning	49
33	E7	Upper Benton Creek thinnings	51
34	B8	Canyon Creek thinnings	53
35	C8, C9	Center Ridge thinnings	55
41	D2	Pruning tests	57
42	C4, B5	Ida Creek pruning area	59
45	D2, G1, H1	Defective tree disposal	61
50	F2	Jurgen's Flat clear cutting	63
51	G2	Knoll Area	65
52	E6	Koch cutting test	67
60	E7	Growth and yield of western white pine	69
61	G2	Weidman Arboretum	71
62	D2	Racial variation in ponderosa pine	73
63	E1	Prolific white pine seed tree	75
64	C7	Pole blight of western white pine	77
65	E5	White pine blister rust	79
66	D12,D14,E13	Canyon Creek Natural Area	81
67	E5, F4	1922 burn	83
68	E-4	Lodgepole pine - jack pine hybrid (not shown on map)	85


1 2 3 4 5 6 7 8 9 10 11 12 13 14
N
W
E
S
TO COOLIN
EAST RIVER
PRIEST RIVER—COOLIN COUNTY ROAD
Ida Cr.
CANYON CREEK ROAD
Canyon Creek
EAST RIDGE ROAD
IDA POINT
CENTER RIDGE ROAD
FOREST HEADQUARTERS
Benton Creek
SOUTH RIDGE ROAD
GISBORNE MOUNTAIN L.O.
PRIEST RIVER
Fox Cr
Big Cr
TO PRIEST RIVER
0 1/4 1/2 1
MILES
Legend
EXPERIMENTAL FOREST BOU
ROAD
TRAIL
⑤ DESCRIBED AREA
■ SAMPLE PLOT
● WEATHER STATION
TREATED AREA

WHAT TO SEE AND WHERE TO FIND IT ON THE PRIEST RIVER EXPERIMENTAL FOREST

Idaho

Agriculture — Missoula

FOREST FIRE STUDIES

The millions of acres of black and barren forest land left by the 1910 and 1919 fires grimly testified to the need for an intensive fire research program. But it was not until 1922 that a full-time fire research worker was assigned to the station. At that time the first organized fire research program in the history of the Forest Service was started at the Priest River Experimental Forest.

From the beginning of the fire research effort, it was apparent that many complex problems blocked the road to adequate and economical protection of millions of acres of forest lands in rough mountainous country. However, it soon became evident that progress in fire control demanded a better knowledge of fire behavior, and more specifically better knowledge of how to accurately rate fire danger under various fuel, weather, and topographic conditions.

In the early years of fire research the major effort was devoted to studies of the influence of weather on fire danger. Fire research workers had in mind that the men responsible for the fire fighting job needed some simple device which would rate the day-to-day variations in fire danger. By 1931, the experiments conducted at Priest River had progressed far enough to permit design of the first fire danger meter, a device which integrates measurements of fuel moisture, relative humidity, wind, season of year, occurrence of lightning, and visibility distance into one numerical rating.

Studies of fuel moisture and its response to weather changes showed that a direct measure of moisture in duff and fine forest fuels was far more dependable than its indirect determination from measurements of temperature, relative humidity, evaporation, or precipitation. Several instruments for measuring fuel moisture were developed and tested at Priest River. Pioneering work with duff hygrometers and fuel moisture indicator sticks not only produced a practical system of fuel moisture measurement in the northern Rockies, but was an incentive for other workers to develop similar devices now commonly used throughout the United States. Several of the instruments developed for fire danger measurement may be seen in the Priest River laboratory.

A number of important fire danger factors were measured at the three stations of Area 2. Meteorology from the forest floor to above the tree tops was studied on the 150-foot steel tower of Area 1. Differences in fire danger between north and south aspects on lower, middle, and upper slopes (Area 3) were investigated on Gisborne Mountain; at Gisborne Mountain lookout devices and methods were tested for measuring the distance from which a small fire is visible.

The condition of herbaceous vegetation which has an important bearing on fuel inflammability is being studied on Area 2 and on Area 5. The moisture content of large logs, which may be an important indicator of critical burning conditions, is being studied on Area 2.

Advancements in fire danger rating have continued through the years. Today, in addition to an improved fire danger meter, fire control men have a burning index meter which evaluates inflammability throughout the fire season. Recent research has led to the design of an experimental rate of spread computer which shows how fast a fire will gain perimeter. Fire control men are now equipped with tables which show how to convert burning index as measured at a fire weather station to the probable burning index at the site of a fire. Tables also have been issued showing rate of spread according to converted burning index, fuel type, and steepness of slope.

Prevention of lightning -- the number one fire cause in the northern Rocky Mountains -- has recently been explored in a preliminary way. Through the cooperation of Dr. Vincent Schaefer of General Electric Research Laboratories, a study was made of the possibility of seeding certain types of clouds to dissipate their lightning-forming potential before they began discharging into forested areas. (See Area 1, Forest Weather Tower, for a description of the project.)

To a very large extent as a result of these various studies, forest fire protection agencies now use systematic fire danger rating in planning best placement of facilities in the day-to-day manning of their organizations, and in determining the level of action called for on individual fires. Fire research at Priest River has helped obtain better forest fire control at less cost not only in the northern Rockies but in many other regions of the country where similar methods of measuring forest fire danger have been applied.

FOREST WEATHER TOWER
Area 1

This 150-foot steel tower was erected in 1934, with the aid of CCC funds and labor, for studying variations in climate within the forest from the ground up through the canopy. Such a study was needed to answer many practical questions concerning the effect of a forest on its own environment and the effect of a forest canopy on burning conditions, or inflammability, within the canopy.

Wind velocity, air temperature, and relative humidity were measured continuously with automatically recording instruments at five levels on this tower during the summers from 1938 through 1941. Results of the wind velocity measurements were published in a Station progress report, "How the wind blows in the forests of northern Idaho".

At the top of the tower are a sunshine thermometer, an anemometer, and a wind vane which are connected with the quadruple register in the laboratory where sunshine duration, unimpeded wind velocity, and wind direction are charted along with precipitation measurements from the weather station.

The tower was used during the summer of 1948 and 1949 to aid in a study of lightning prevention. A widespread interest in rain making resulted in a decision to seek the assistance of Dr. Vincent G. Schaefer, research chemist at the General Electric research laboratories. Dr. Schaefer, the originator of the dry-ice method of cloud seeding, believed that seeding might reduce or eliminate lightning from orographic cumulus clouds which are prolific lightning producers. Separate orographic cumulus clouds normally originate over Hoodoo and Gisborne Mountains and the North Baldy region in the Priest River area. However, plans to seed clouds during 1948 and 1949 were not carried out because suitable conditions failed to appear. To date the method has not been tested.

Dr. Schaefer's observations and recommendations are reported in detail in Station Paper No. 19.

CLEAR-CUT, HALF-CUT, AND FULL-TIMBER INFLAMMABILITY STATIONS
Area 2

At the clear-cut station various factors of forest fire danger have been measured during each fire season since 1922. This is the oldest fire danger station in the United States. It was here that duff hygrometers and fuel moisture sticks were first developed and tested. An instrument for simultaneously measuring wind movement and fuel moisture content and recording the measurements was also devised here. Much of the information upon which the Northern Rocky Mountain Burning Index Meter and Fire Danger Meter are based was gathered on Area 2. The meters are devices for rating inflammability and fire danger each day during the fire season, May 1 to October 31. They are now in operation at more than 175 fire danger stations in the northern Rocky Mountain region, including stations on 17 national forests, 2 national parks, and 2 Indian reservations. Similar meters are now found in all forest regions throughout the United States.

Since 1931 the clear-cut station has been one of the many standard fire danger stations in the northern Rockies. In 1930 the half-cut and full-timber stations were established in their present locations in order to measure fire danger factors under different densities of forest canopy.

At present, moisture content and date of curing for yarrow, a plant which appears to be a good indicator of the burning conditions in herbaceous vegetation, are being measured at the clear-cut station. Throughout the fire season at the clear-cut and full-timber stations, moisture content of large logs is measured as an indication of the gradual drying of heavy fuels to dangerous burning conditions.

Findings from these three stations have been published in several reports that deal with fire danger measurements. Detailed results may be found in "The significance of the effect of stand density upon the weather beneath the canopy", Journal of Forestry, Vol. 32, No. 4, 1934; "Influence of weather factors on moisture content of light fuels in forests of northern Rocky Mountain region", Journal of Agricultural Research, Vol. 51, No. 10, 1935, both by George M. Jemison; and "Measuring fire weather and forest inflammability", U. S. Department of Agriculture Circular No. 398, by H. T. Gisborne, 1936.

These stations were also used in 1932, 1933, and 1934 to study weather factors that influence the initial establishment of tree seedlings. (See Forest Management Section, White Pine Regeneration, Area 2.)

The effect of timber cover on snow accumulation and retention is now being studied at the clear-cut and full-timber stations. These two stations provide extremes in crown cover density at relatively low elevation. The table below shows that because of crown interception less snow reaches the ground in the timber than in the clear-cut area. Shading, reduced air movement, and differences in temperature cause snow in the timber to melt more slowly than snow in the logged area and to lose less moisture by evaporation.

Date (1949)	Water content of snow	
	Clear-cut station	Full-timber station
	Inches	Inches
February 2	7.3	4.3
February 27	9.7	7.4
March 8	6.7	6.2
March 22	7.5	6.6
March 30	6.0	7.1
April 5	1.6	5.4
April 12	Bare	3.9
April 19		1.7
April 27		Bare

ALTITUDE AND ASPECT STATIONS
Area 3

A forest fire's behavior differs according to elevation and aspect. But why? And to what extent do burning conditions vary from the valley bottom to the mountain top and on north and south slopes? To determine the answers, in 1934 three pairs of fire danger stations were set up and equipped with recording instruments. One station of each pair was located on the north slope, the other on the south slope at elevations of 2700 feet, 3800 feet, and 5500 feet. In order for these measurements to be related to valley bottom conditions, similar weather and fire danger factors were measured at the clear-cut and half-cut stations at 2300 feet. Complete records were obtained for the fire seasons from 1935 through 1939.

The outstanding result of this study was the discovery of a thermal belt, part way up the mountain side, within which all factors combined to put fire danger at its highest peak. Danger in the thermal belt is relatively higher at night in comparison to the valley bottoms and ridge tops. During the night cold, moist air drains into the valley bottoms, while within the belt the air remains warm and dry and forest fuels remain dry. Since the discovery of these dangerous thermal belts, the behavior of several large fires has verified their importance.

Recent fire research has made further use of the original findings at the several fire weather stations on Gisborne Mountain. Tables have been prepared which show how to convert burning index as measured at either a valley bottom or a mountain top station to the probable burning index at a fire burning at some other position on a mountain slope. Detailed analysis of thousands of forest fires has shown the influence of burning index on fire behavior. Tables have been prepared to assist fire dispatchers and fire bosses in calculating how fast a fire will spread according to burning index, fuel type, and slope steepness. Work is continuing on the development of a rate of spread computer, a device which will integrate all fuel, weather, and topographic factors to show how fast a fire will gain perimeter.

These studies enable fire control men more accurately to predict the behavior of fires and to plan fire supervision requirements accordingly. The result is more efficient fire control at less cost.

Original results of these studies have been published in U. S. Department of Agriculture Circular No. 591, "Influence of altitude and aspect on daily variations in factors of forest fire danger", by G. Lloyd Hayes, 1941. More recent results are contained in Research Note No. 100, "Correction of burning index for the effects of altitude, aspect, and time of day", and Station Paper No. 29, "Fire behavior in northern Rocky Mountain forests".

GISBORNE MOUNTAIN LOOKOUT
Area 4

Until Harry T. Gisborne's assignment to the Priest River Experimental Forest in 1922, forest fire control had been studied only piecemeal. Gisborne was the first full-fledged student of forest fire control research. He intensely believed that fire control must be reduced to a scientific basis. His enthusiasm and imagination fired his fellow workers, and under his leadership outstanding contributions to forest fire research were made. He died in 1949, internationally recognized for his achievements.

In his honor, in 1950 the lookout on the Experimental Forest was renamed Gisborne Mountain Lookout. This had particular significance, for Gisborne had carried on many of his fire studies from that point, then known as Looking Glass Lookout.

The original Forest lookout was $1\frac{1}{4}$ miles east of the present location. Using weather records from there, J. A. Larsen, at the time Director of the Experiment Station, pioneered in fire weather study. His results, "Weather records at lookout stations in northern Idaho", were published in the Monthly Weather Review for January 1922.

In 1933 the lookout was moved for better detection coverage. One of many standard fire danger stations used by the Forest Service to rate fire danger each day during the fire season, it is equipped with instruments furnished by the Experiment Station and the Weather Bureau.

The lookout tower offers an inspiring view of Canyon Creek Natural Area (Area 66) and the country beyond.

VEGETATION STATION
Area 5

The forest fire man knows that green vegetation such as grasses, weeds, and shrubs, retards fire but when fully cured it ignites easily and spreads fire rapidly. However, the simple questions -- when is vegetation green, when is it curing, and when is it cured -- have not yet been satisfactorily answered.

From 1935 through 1939, samples were collected of four different species of shrubs, four species of herbs, and one species of grass from Area 5 at 10-day intervals from early June until mid-September. Soil moisture contents were determined from the 0- to 6-inch, 6- to 12-inch, and 12- to 18-inch layers. Detailed measurements of the current year's growth of sample plants, and notes of the condition and color of this growth were recorded at these same intervals. Moisture contents of all samples were determined, ether extractions were made of the total crude fat content, and the calorific or heat content was measured by use of a Parr peroxide bomb calorimeter.

This project was a pioneer effort for similar studies having the same objectives had never before been made. Although considerable information was acquired in this study of vegetative condition in relation to fire danger, no directly applicable method of fire danger measurement has yet come from the study. Part of the results of the chemical phase of the project are reported in "Effect of certain chemical attributes of vegetation on forest inflammability", by Dr. Leon W. Richards, Journal of Agricultural Research, Vol. 60, No. 12, 1940. A summary of earlier findings is contained in "Effect of low vegetation on the rate of spread of fire in the northern Rocky Mountain region", a thesis submitted by George M. Jemison at Yale University, 1936.

Due to wartime reductions in forest research, work on the project was reduced to routine measurement of vegetation throughout the fire season. These measurements are still being continued.

SPECIAL FLOOD CONTROL STUDIES

The special flood control studies on the Experimental Forest are mainly short-term projects designed to furnish some basic information for the Columbia River Watershed flood control report. With minor adjustments, these studies could easily be converted to long-range forest influences projects.

The objectives of the special flood control studies are:

1. To determine the interrelationships between a variety of vegetational and topographic conditions and snow accumulation, snow melt rates, soil and air temperatures, soil moisture, frost conditions, rainfall, and other factors affecting runoff.

2. To determine the relationships of streamflow to vegetational cover, topography, snow accumulation, melting rates, and weather conditions.

The snow studies began in the fall of 1948. Many of the studies have utilized instruments and study sites previously used for fire and silvicultural research. The control weather station, long maintained for fire research purposes, is the index meteorological station for the snow studies. The altitude-aspect stations which had been established for fire research summer studies were ideal for providing data on the influence of altitude and aspect on snow accumulation and melt. Valuable data were secured from snow courses and winter-operated meteorological stations in a transect originally cleared for fire studies. The clear-cut and full-timber stations on Area 2, which contributed significantly to fire and silvical knowledge, were used for snow studies. Snow was also measured in stands of various crown densities in silvicultural thinning plots.

CONTROL WEATHER STATION
Area 10

Detailed and accurate weather records constitute one of the foundations of forest influences, forest fire, and silvicultural research. Such records are an essential part of the snow projects.

Weather measurements were started at the Priest River Station in the fall of 1911. From May 1914, when the instruments were moved to their present location, up to the present an unbroken series of daily measurements has been obtained. In addition to the utilization of the data at the Station, the weather is reported to the Weather Bureau at Boise, Idaho, and during the summer fire season to the Weather Bureau in Missoula, Montana. At Boise the daily measurements are summarized and published in monthly, annual, and periodic climatological summaries for Idaho. At Missoula, fire-weather forecasts, issued daily, are based upon measurements from this and similar weather stations.

The Experiment Station has added several instruments to the station since 1922. Its present equipment is the most complete and accurate of any forest station in the northern Rocky Mountain region. An instrument of especial importance is the "tipping bucket" precipitation gage that leaves its record on the quadruple register chart in the office.

The table on the next page summarizes weather records taken at the station.

WEATHER SUMMARY
Priest River Experimental Forest
Control Weather Station
1912 - 1950

Month	Precipitation					Temperature						
		Maximum		Minimum				Maximum			Minimum	
	Mean 1/	Amount	When occurred	Amount	When occurred	Mean 1/	Mean maximum 1/	Amount	When occurred	Mean minimum 1/	Amount	When occurred
	Inches	Inches	Year	Inches	Year	°F	°F	°F	Year	°F	°F	Year
January	3.76	6.70	1935	0.70	1949	23.6	30.5	49	1912,1923	16.9	-33	1950
February	2.79	6.53	1948	0.57	1913	27.3	36.4	57	1947	17.5	-35	1935
March	2.55	5.99	1945	0.25	1926	34.8	46.3	69	1921	23.9	-18	1945
April	1.91	4.51	1948	0.30	1924	43.8	58.0	88	1934	29.5	- 1	1936
May	2.10	6.24	1941	0.72	1935	51.4	66.9	97	1936	36.0	22	1913,1923
June	1.98	4.92	1948	0.14	1922	58.0	74.3	97	1912	42.0	24	1918
July	0.84	3.43	1948	0.03	1929	64.4	83.6	102	1924	45.0	28	1917
August	0.96	4.24	1926	Trace	1931	62.6	82.3	100	1930	42.8	28	1918,1924
September	1.75	7.50	1927	0.03	1943	54.1	70.4	96	1938	37.4	16	1926
October	2.64	8.31	1947	0.59	1936	44.4	56.4	83	1935	31.6	- 5	1935
November	3.60	7.69	1937	0.11	1929	33.2	39.9	61	1931	26.4	- 8	1921
December	4.31	11.22	1933	0.91	1913	26.6	32.4	55	1922,1923	20.6	-28	1927,1931
Annual	29.19	41.34	1927	16.02	1929	43.7	56.5	102	1924	30.9	-35	1935

1/ 30-year mean: 1912-1941, incl.

BENTON CREEK STREAMFLOW GAGING STATION
Area 11

Benton Creek is a "Little Waters", typical of creeks that originate at small springs in the mountains, flow swiftly down steep grades through forest and range land to join and form the minor and then major rivers. Except for minor contributions from rainfall, flows are derived from the melt of winter snows. The volume and duration of flow is dependent on the meteorological conditions during the melt period and the ability of the watershed to influence melt rates, to infiltrate water, and to release it gradually from subsurface reserves. Findings are expected to help explain how man can control streamflow by manipulation of the vegetal cover.

The Benton Creek gaging dam was built in 1938. It is equipped with two weirs. The small weir accommodates low flows. When its capacity is reached excess water flows over the large, broad-based weir. A water stage recorder gives a continuous record of runoff flow from this 960-acre forested watershed. Benton Creek has the largest discharge record of any small, gaged watershed in the entire region. The spring peak generally occurs in May. Fall rains and the melting of early winter snow cause an appreciable rise in December.

With the initiation of flood control survey studies, the streamflow records of Benton Creek became one of the key sources of data. The record permitted immediate analysis and is an essential part of the work outlined under "Hydrology of Benton Creek Watershed", Area 15.

The table on the next page summarizes streamflow measured at the gaging station.

MEAN DISCHARGE
UPPER BENTON CREEK WATERSHED
At Benton Creek Gaging Dam
Priest River Experimental Forest

Year	Mean discharge per second per square mile												
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly
	Cu. ft.												
1939	.194	.165	.372	1.252	1.652	.596	.305	.178	.138	.145	.132	.248	.448
1940	.169	.292	1.400	2.687	1.864	.594	.266	.157	.166	.171	.192	.320	.690
1941	.386	.400	1.208	1.361	1.502	1.062	.473	.270	.317	.314	.454	1.885	.803
1942	.898	.644	.536	2.217	2.045	1.650	.920	.393	.249	.211	.382	.327	.873
1943	.234	.290	.481	4.807	2.764	1.728	.791	.348	.203	.239	.209	.305	1.033
1944	.175	.170	.200	.951	1.277	.987	.393	.207	.145	.120	.127	.135	.407
1945	.222	.329	.661	.983	4.916	1.579	.463	.226	.181	.163	.345	.423	.873
1946	.459	.286	.855	3.587	5.224	1.725	.677	.312	.215	.185	.408	.911	1.237
1947	.573	.939	1.628	2.287	2.100	.887	.482	.272	.219	.593	.769	.636	.949
1948	.703	.529	.550	2.909	7.119	3.015	1.223	.595	.347	.248	.262	.205	1.475
1949	.193	.370	.852	3.968	5.913	1.106	.426	.247	.194	.201	.265	.238	1.164
1950	.225	.333	1.247	2.383	6.514	3.752	.990	.415	.258	.388	.608	1.946	1.588
Mean	.369	.396	.832	2.449	3.574	1.557	.617	.302	.219	.248	.346	.632	.962

COOPERATIVE SNOW COURSES
Area 12

The amount of rain a watershed receives and the rate at which it falls are measured with precipitation gages. The amount of water stored in the snow pack and the rate of melt are measured by periodically weighing sample cores of the snow on marked courses.

Snow measurements on the Benton Spring and Benton Meadow courses began in 1937. The Benton Spring course is located at the head of Benton Creek and the Benton Meadow course is near the Station headquarters. The Division of Irrigation of the Soil Conservation Service, by utilizing data from these monthly readings and a network of other courses throughout the Columbia Basin, establishes indices from which prospective water supplies are estimated to guide operation of irrigation, power, and flood control facilities.

Information from these courses is used with that of other flood control studies on the Experimental Forest.

The table on the next page summarizes 14 years of measurements on the Benton Spring and Benton Meadow snow courses. Elevation and character of cover are largely responsible for the difference in measurements on these two courses.

BENTON SPRING AND BENTON MEADOW SNOW COURSE MEASUREMENTS
Snow Depth and Water Content

Benton Spring Snow Course (Elevation 4900 feet)

Year	January 1		February 1		March 1		April 1		May 1	
	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content
					Inches					
1937	19	4.2	44	9.8	60	17.7	54	19.0	49	20.3
1938	51	13.7	58	17.0	68	23.3	75	28.3	43	19.9
1939	25	4.9	49	13.2	58	18.5	42	18.9	10	5.2
1940	15	4.3	22	7.8	48	14.2	33	14.2	10	4.5
1941	32	7.2	45	12.7	38	12.6	25	10.0	0	0
1942	19	3.3	23	5.2	35	8.8	33	10.1	7	2.3
1943	36	11.6	60	19.8	59	21.3	62	22.0	24	13.3
1944	13	4.6	25	8.7	32	10.8	28	10.3	10	4.8
1945	22	7.0	31	10.4	39	14.4	65	20.8	50	21.0
1946	42	12.5	60	19.6	74	27.0	73	29.4	48	22.6
1947	32	8.6	52	14.6	44	16.5	42	16.3	15	6.3
1948	24	6.4	36	11.2	60	19.6	61	22.5	50	20.6
1949	51	15.7	50	16.8	82	29.8	82	32.8	40	20.4
1950	35	8.5	55	18.4	59	20.9	73	27.6	59	26.1
14-year mean	30	8.0	44	13.2	54	18.2	53	20.2	30	13.4

Benton Meadow Snow Course (Elevation 2344 feet)

Year	January 1		February 1		March 1		April 1		May 1	
	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content	Snow depth	Water content
					Inches					
1937	6	0.9	24	4.6	33	9.5	6	3.0	Snow all melted by May 1	
1938	10	3.0	25	5.1	26	7.8	7	2.7		
1939	10	1.8	24	4.1	29	7.3	3	1.3		
1940	6	0.8	12	2.8	21	6.6	0	0		
1941	10	2.1	14	4.2	12	3.6	0	0		
1942	0	0	0	0	5	1.4	0	0		
1943	11	4.7	28	8.6	24	10.5	9	4.8		
1944	2	0.9	7	2.7	10	4.4	0	0		
1945	13	4.3	12	4.8	6	2.5	2	0.5		
1946	6	1.5	22	5.1	23	7.7	3	1.0		
1947	13	2.0	17	4.0	3	0.9	0	0		
1948	6	1.4	12	3.3	18	4.7	6	1.5		
1949	28	6.6	30	7.3	30	9.3	13	4.1		
1950	20	4.4	36	9.8	29	9.7	18	6.7		
14-year mean	10	2.4	19	4.7	19	6.1	5	1.8		

TRANSECT SNOW STUDIES
Area 13

The transect is a clear-cut strip 300 feet wide extending from South Ridge to Benton Creek and up the opposite slope to Center Ridge. It was cleared of all timber in 1940 in preparation for a study to measure differences in fire danger that exist from the ridge top to the creek bottom and up the opposite slope in a mountain valley. Although this study was never undertaken, the transect is being used for studies of snow.

The snow studies in the transect were established to determine the effects of cover, aspect, slope position, and elevation on snow accumulation and melt. They supplement the data from the altitude-aspect stations which are located near the crest of a ridge (Area 14). Snow course measurements are taken at the upper, middle, and lower slope positions on both the north- and south-facing slopes. The courses extend across the transect and into the timber on each side in order to measure the influence of the opening on snow accumulation and melt in the adjacent timber and vice versa. A pair of meteorological stations -- one in the timber and the other in the transect -- are located at the middle slope positions on both the north and south slopes. Temperature, wind, and relative humidity are recorded continuously, and precipitation is measured in non-recording gages. The information from these stations aids in the interpretation of snow course data and in developing methods of estimating snow melt rates.

The table on the following page indicates the differences in snow accumulation and melting that can occur under a forest and in an opening within a small range in elevation. It also indicates the great difference in snow accumulation and melt between a north-facing and a south-facing slope.

TRANSECT SNOW MEASUREMENTS
Winter 1948-49

Date (1949)	North-facing slope						South-facing slope					
	Upper		Middle		Lower		Lower		Middle		Upper	
	Opening	Timber	Opening	Timber	Opening	Timber	Opening	Timber	Opening	Timber	Opening	Timber
	- - -	- - -	- - -	- - -	- - -	- - -	- Inches -	- - -	- - -	- - -	- - -	- - -
Jan. 27-28	11.6	10.4	12.3	8.2	12.2	6.4	10.2	6.4	10.3	6.0	10.6	6.2
March 1	18.5	14.9	18.6	11.1	16.4	10.0	12.0	8.1	10.9	7.9	13.8	8.2
March 24	19.8	16.9	18.9	12.5	16.6	10.9	8.0	7.1	7.6	4.8	9.9	4.8
March 30-31	20.6	17.7	22.1	13.2	19.8	9.6	7.4	8.0	5.2	4.9	9.2	5.3
April 5-6	19.4	17.5	20.5	12.3	17.8	7.9	1.5	6.1	0.4	1.4	3.3	2.5
April 12	15.4	13.1	16.3	7.7	12.6	5.0	Bare	2.6	Bare	Bare	Bare	Bare
April 19	11.1	9.7	11.9	5.8	8.4	2.4		0.2				
April 26	8.3	7.5	7.7	3.3	2.8	1.2		Bare				
May 3	2.9	2.7	1.0	1.9	0.3	0.6						
May 10	0.6	Bare	Bare	0.6	Bare	Bare						
May 16	Bare			Bare								

SNOW STUDIES AT ALTITUDE AND ASPECT STATIONS
Area 14

More snow can be expected at higher elevations than at lower levels, and usually more snow accumulates and remains longer on north slopes than on south slopes. Quantitative expressions of these principles were needed in connection with the Columbia River flood control survey. Winter installations at the six altitude-aspect stations include wind velocity and temperature recorders, non-recording precipitation gages, and snow courses. An additional pair of stations, facing east and west, was established at the 2700-foot elevation and used during the 1949-50 season. These installations provide data for measuring the relationships between altitude and aspect and snow accumulation and melt, and the effect of wind and temperature on snow-melt rates -- all important factors in designing and evaluating the flood control program.

The altitude-aspect snow data for the winters of 1948-49 and 1949-50 are shown on the next page.

ALTITUDE-ASPECT STATIONS
Snow Measurements

Date	2700 feet		2700 feet		3800 feet		5500 feet	
	East	West	North	South	North	South	North	South
1949	Inches							
Jan. 18-21					12.1	7.8	21.6	19.4
Feb. 3			9.9	6.7				
Feb. 25-28			11.7	5.1	17.3	7.8	36.5	30.1
March 7-8			8.7	0.9	16.2	2.5	36.2	27.7
March 21-22			9.9	0.1	19.9	2.1	41.1	30.9
March 28-30			8.9	Bare	20.6	0.8	40.2	33.4
April 4-5			6.7		18.9	Bare	40.8	31.2
April 11			Trace		15.2		39.9	24.6
April 18			Bare		8.5		36.1	16.8
April 26					3.5		35.4	14.0
May 2					Bare		30.9	8.5
May 9							29.3	1.4
May 16							13.4	Bare
May 23							3.1	
May 30							Bare	
1950								
Feb. 8-10	10.4	9.3	12.8	8.1	15.6	11.0	27.0	15.8
March 7-8	8.6	7.4	12.8	3.9	18.4	8.0	37.4	23.3
March 23-24	6.8	6.1	13.3	1.6	20.0	8.7	41.8	25.8
April 5-6	4.2	Bare	12.0	Bare	21.4	5.6	42.0	27.1
April 12-15	1.3		10.7		20.0	1.1	43.7	28.1
April 17-20	Bare		6.0		17.1	Bare	43.4	27.0
April 25-26			3.4		15.4		42.5	23.9
May 1-2			Bare		12.5		42.9	24.5
May 10					9.3		45.5	24.2
May 16					Bare		37.9	12.2
May 24							32.0	6.3
May 3							25.5	2.1
June 5							15.6	Bare
June 12							6.7	
June 19							Bare	

HYDROLOGY OF BENTON CREEK WATERSHED
Area 15

Snow and rain are the sources of water which runs over the surface, sinks into the soil, is used by vegetation, produces streamflow, and causes soil erosion and floods. Streamflow may be regarded as the residual after all water losses due to such factors as evaporation, transpiration, and contributions to deep ground water supplies are subtracted from total precipitation. The water cycle may be expressed simply, but in practice it is subject to many complicating influences including elevation, aspect, slope gradient, vegetation, and, especially in the case of snow to temperature, relative humidity and wind. An understanding of the interrelationships between these influences is basic to sound planning and evaluating of flood control programs and to good watershed management.

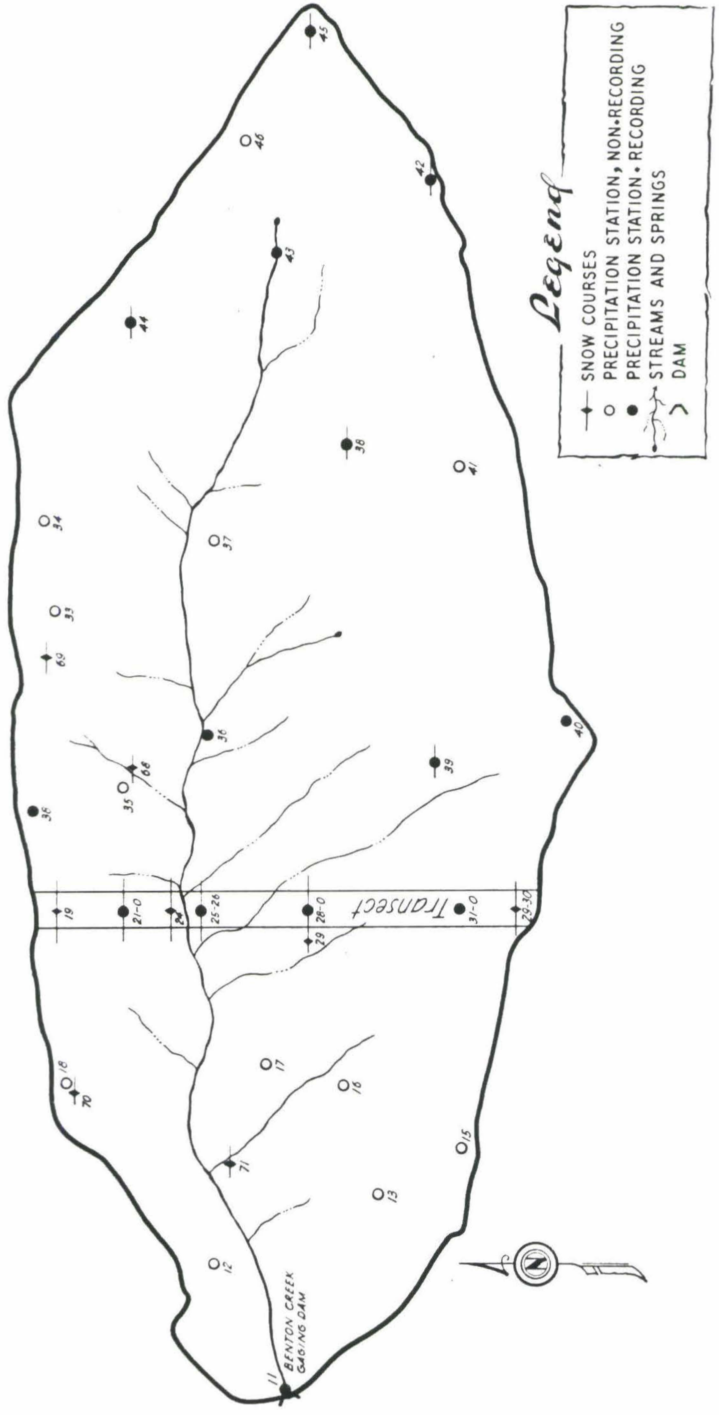
The map on the following page shows the network of 20 non-recording and 5 recording precipitation gages used to determine the amount of rain and snow falling within the 960-acre gaged watershed area, bounded on the map by the heavy solid line. The stream gaging station (at Station No. 11) measures the amount of streamflow out of the gaged area.

Fifteen snow courses, indicated on the map, are used to determine the amount of water in the form of snow on the catchment area surface and are measured weekly during the snow-melt season. Indications of soil moisture prior to, during, and after the snow-melting season are obtained by direct sampling at each of the snow courses, and by special electrical soil moisture units located at strategic points.

These watershed data permit the sources of streamflow to be segregated into the residual water from rainfall, snow melt, and groundwater flow. These three immediate sources of runoff may be correlated with meteorological factors such as temperature, relative humidity, and wind that are measured at Stations No. 11, 21, 28, and 45.

A stream gage at Benton Spring records the flow of water at the point where Benton Creek water first comes to the surface.

The study within the gaged portion of Benton Creek is one of the first attempts in this region to determine the hydrologic factors and how they operate within a forested watershed which derives most of its precipitation in the form of snow. From a preliminary study made in 1939 and 1940 it was estimated that only about 25 percent of the total precipitation in this basin flowed past the stream gaging station.



SNOW COURSES AND PRECIPITATION GAGES IN THE BENTON CREEK WATERSHED

FOREST MANAGEMENT STUDIES

A tent pitched in the clearing of 50-year-old white pine on August 28, 1911, established the first camp at what is now Priest River Experimental Forest. Thus did organized research in the northern Rocky Mountain region begin.

Little then was known about the basic silvical requirements of the native trees of the region or the silvicultural methods for their management. The year before 3½ million acres had been denuded by fire. Methods of planting and seeding to get the land back into production were essential. Information was urgently needed by an expanding timber sale business on the newly created national forests on how to cut the virgin timber to obtain desired reproduction. Foresters wanted information on growth and yield in order to plan cutting budgets. The Experimental Forest was created to meet these demands which largely governed the choice of investigative projects on the Forest during its earlier years. Early projects included studies of nursery and planting practice, basic requirements and habits of the species making up the western white pine type, and harvest cutting methods for the western white pine type.

A weather station was immediately set up to measure the factors of climate affecting tree growth in the area. One set of thinning plots was established in 1914 and another in 1919 to study stand improvement. During the early years, the Priest River Forest was the regional headquarters for all forest management research in Montana and northern Idaho. In 1921 headquarters were moved to Missoula, but most of the research continued to be centered at Priest River.

During the 1920's, some change in emphasis occurred in forest management research. The Priest River Forest was used more for a working base than a field laboratory because a wider range of conditions was needed for study. However, several plots and tests were established on the Experimental Forest as part of these expanded studies. Permanent harvest cutting plots were established on many cut-over and burned-over areas in the Kaniksu and Coeur d'Alene National Forests, several of them within or adjacent to the Experimental Forest. At that time a type-wide study of growth and yield of second growth white pine stands resulted in establishment of several permanent yield plots on the Forest. Basic work in silvics and a few tests of stand improvement were also conducted on the Priest River Forest during this period. Several years previously planting and nursery studies had been transferred to Savenac Nursery in Montana.

In the early 1930's intensive silvical studies of factors affecting early seedling survival were carried out and completed on the Experimental Forest. The methods-of-cutting studies of white pine, started in the previous decade at the Priest River base, were also completed. The CCC program created an immediate need for knowledge about stand improvement and many tests were established on the Forest. The Deception Creek Experimental Forest was established in 1934 and much of the forest management research was conducted there.

World War II and the termination of the CCC program were chiefly responsible for reducing forest management research at Priest River Experimental Forest to a maintenance level during the 1940's. However, permanent sample plots, including tests of harvest cuttings, stand improvement, and growth and yield continued to be measured.

Forest management research at the Forest is now revived. The importance of intermediate harvest cuttings in immature stands is being recognized. Timber sale activities have been stepped up to test intermediate and final harvest cuttings. Long-time permanent sample plots of harvest cuttings, stand improvement, growth and yield, and ponderosa pine racial variations are measured periodically. The newest study is a field test of lodgepole pine-jack pine hybrids.

WHITE PINE REGENERATION
Area 2

(See Forest Fire Studies Section, Area 2, for description of fire studies on the same plots.)

In the mixed western white pine type one of the chief silvicultural problems has been to obtain as large a proportion as possible of the more valuable species in the seedling stand. Under such circumstances, it is especially important to know the effect of individual site factors, and how they may be altered by stand treatment in order to encourage adequate reproduction of the more desirable species wherever possible by proper cutting practices.

First-year seedling establishment was studied in much detail on Area 2 from 1932 to 1934. Since overwood density is one of the more important factors controlled by silviculturists during the regeneration period, the three degrees of forest canopy -- dense, moderate, and none -- on Area 2 made the plots well suited to the investigation. The climatic records collected for fire research also increased the utility of the plots for the study of factors controlling initial establishment of white pine and associated tree species. The study of natural regeneration was conducted on small sown plats representing natural mineral soil, burnt mineral soil, and duff surfaces. Some plats were specially treated by watering, trenching, or screening. Each plat was sown heavily enough to insure a large sample of seedlings. Seedling mortality was classified after careful diagnosis of causes and with knowledge of the important agents operating at the time. Certain check plats were used effectively in segregating causes, but the most satisfactory control came in instrumental measurement of important site factors, including surface soil temperature and soil moisture.

The study showed that on the severe river flat habitats where the experiments were conducted, it is advisable to leave a moderate amount of shade to lessen the influence of the sun and assure a satisfactory quantity of regeneration. Under full-sun conditions, western white pine and its hardier associates are favored the most over western redcedar and hemlock but attainment of full stocking is apt to be slow. The retention of too heavy shade results in an appreciable increase of the more shade-tolerant species.

Experimental methods and results have been reported in detail in Yale University School of Forestry Bulletin No. 41, by I. T. Haig, 1936; and U. S. Department of Agriculture Technical Bulletin No. 767, by I. T. Haig, K. P. Davis, and R. H. Weidman, 1941.

BREWSTER PLANTATIONS
Area 25

The 1910 burns in Idaho and Montana left large areas of denuded forest land. If the deforested mountains and valleys were to be cheaply and effectively restored to productive condition by planting, much technical information was needed quickly. D. R. Brewster, the first Director of the Experiment Station, devoted much of his time to the study of planting. Because many of his studies were carried on in Area 25, the resulting plantations were named in Brewster's honor.

Early planting research covered a variety of projects -- tests of age classes of planting stock, size of stock, season of planting, methods of planting, direct seeding, and trial plantings of exotic and other non-indigenous trees.

Nearly all of the tests of ponderosa pine planting stock from 1912 to 1915 were conducted on Benton Flat, in Area 25, with the remaining tests on a southerly slope nearby. The tests compared growth and survival of 2-1, 1-1, 2-0, and 1-0 stock, and of small, medium, and large 1-2 stock (one year in the nursery seed bed and two years in the nursery transplant bed before lifting for planting). The Benton Flat tests showed no significant difference in survival between 2-1, 1-1, 2-0, and 1-0 stock. However, growth of 2-1 and 1-1 stock was superior to growth of 2-0 and 1-0 stock. For example, in 1929 (nine years after planting), 2-1 stock averaged 74 inches in height and 1-0 stock averaged 39 inches. In a test of three size classes of 1-2 stock, the largest size of stock survived and grew the best; no material differences were observed between medium and small stock. This test, which also compared spring and fall planting, showed that survival was considerably better for spring planted stock and spring plantings made slightly better growth. Analysis of the results led to the conclusion that the differences in survival and growth do not warrant culling of stock for size, but that better survival of spring planted stock is of practical importance. A later test, grading 1-2 stock into eight size classes, showed no material difference in survival between the various size classes although the larger classes grew slightly faster. Tests made on Benton Flats, a good site, plus others on more severe southerly slopes, showed that 2-0 ponderosa pine stock is sufficiently hardy for planting on reasonably fertile sites but 2-1 or 1-2 stock is to be preferred on southerly slopes, with thinner soils and shrubby or herbaceous cover. When planting on more difficult sites, the culling of undersized stock materially increases survival.

These test plots have served their original purpose, and findings from them have been incorporated into the regional planting standards.

Pruning and thinning in the ponderosa pine plantations is described under "Pruning Tests, Area 41."

In addition to the tests of age- and size-classes, exotic and non-native species were planted in Area 25 about the same time. Although most of these species were found to be unsuited to the region, survival and growth of a few species have been good. A Scotch pine (Pinus sylvestris) plantation at the west end of Area 25 has grown exceptionally well. In general, hardwoods have failed, and indigenous conifers have proved to be superior to the non-native and exotic species.

Area 25 is one of several on which the effects of environmental factors upon establishment and growth of seedlings were measured. The results are described in "Site factor variations and responses in temporary forest types in northern Idaho", by J. A. Larsen, Ecological Monographs, Vol. 10, 1940.

Snow deposition and accumulation have also been measured in Area 25. During the winter of 1948-49 the water content of snow in the ponderosa pine plantation and in an adjacent opening was as follows:

Date (1949)	Water content	
	Opening Inches	Plantation Inches
February 3	8.8	5.3
February 27	12.2	9.4
March 9	9.6	6.7
March 22	10.6	7.9
March 30	9.5	7.4
April 5	6.9	6.2
April 12	0.2	1.7
April 19	Bare	Bare

As might be expected, the trees intercepted some of the snowfall which otherwise would have reached the ground, and some of the intercepted snow evaporated. The net result was less snow water under the plantation than in the adjacent opening. However, due to shading and reduced air movement, the snow in the plantation melted more slowly than in the nearby opening.

MARSHALL PLANTATION
Area 26

Fire in August 1922 burned 400 acres of mature and 70-year-old timber in the Fox Creek drainage. The following year the area was logged to salvage the fire-killed timber.

Area 26 is a 15-acre portion of the burn which was planted with 1-2 ponderosa pine from Bitterroot National Forest seed in April 1926. The plantation has been named for Robert Marshall, who planned and supervised the planting. The trees were spaced 8 x 8 feet, or at the rate of 667 per acre. Although the soil was unusually dry at the time of planting, survival at the end of the first growing season was 80 percent, or 533 trees per acre. As training for a group of rangers, fail spots were replanted the next spring, although the stocking was more than adequate. The end of the second growing season showed 694 live trees per acre, or 86 percent of the total number of trees planted. High survival and good growth make this plantation one of the best on the Experimental Forest. Trees in a portion of the plantation were pruned in 1948 and 1949 by Iowa State College forestry students as part of their summer camp training.

LOWER BENTON CREEK PLANTATION
Area 27

Area 27 includes several planted and seeded plots as shown on the map, next page.

Logging in 1919 removed all the mature white pine and left a stand composed largely of old, defective, and unmerchantable western hemlock and grand fir. These residual trees were felled and broadcast burned in 1932. The following spring most of the tract was planted with 1-2 ponderosa pine. A small part was also planted with 2-2 western white pine, and mixed plantations, alternating the species by rows, wese established in the northern part. One small patch was planted with alternate rows of western white pine and 4-2 white spruce (Picea glauca), and another small patch was planted with alternate rows of white spruce and western larch. In the spring of 1934, three acres were planted with Balkan pine (Pinus peuce).

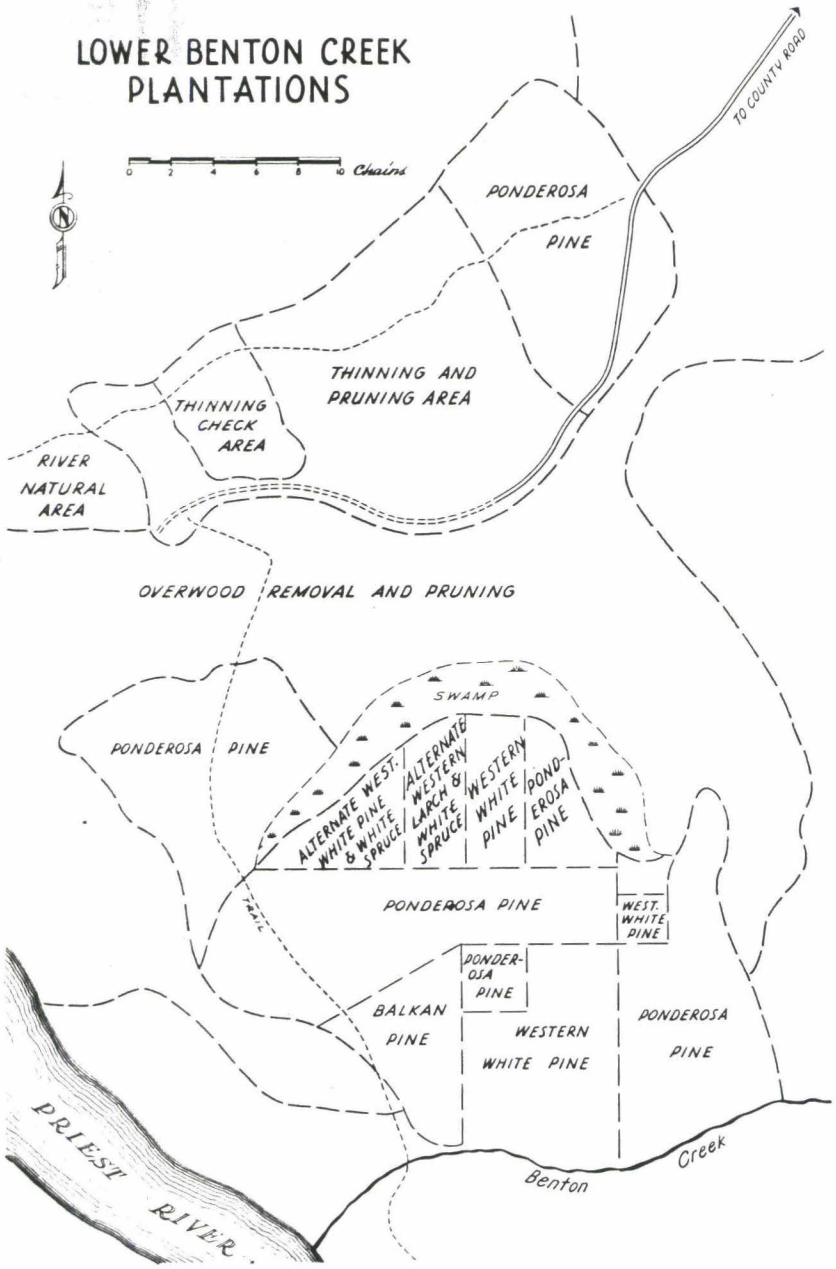
Counts in the fall of 1934 showed the following survival percents:

Ponderosa pine	85
Western white pine	76
Spruce	65
Balkan pine	36
Western larch	0

Nearly all the mortality was believed to be caused by drought.

The Balkan pine and western white pine contain some interesting contrasts. Although both species are susceptible to white pine blister rust, a survey in 1945 showed approximately 25 percent of the western white pine to be infected with blister rust but only about one percent of the Balkan pine. Winter damage during 1948-49 killed considerable foliage on western white pine above the snow level while, nearby, Balkan pines were very lightly damaged. However, these comparisons do not mean Balkan pine should be substituted for western white pine in planting programs in this region because the Balkan pine so far has grown considerably slower than the white pine. In addition, many plantations of exotic trees, both in the United States and other parts of the world, although successful in their early years, have suffered severe damage by disease, insects, or climatic factors when they grew older. For these reasons, exotics should not be planted extensively until long-time experiments have shown they can be grown to merchantable size.

Direct seeding of western white pine was attempted on a three-acre patch where defective and unmerchantable hemlock and grand fir were felled and burned in 1938. Although rodents had been poisoned on the seeded tract, mice migrated from adjacent areas and destroyed the planted seed. The tract was planted with ponderosa pine nursery stock in the spring of 1941.


LOWER BENTON CREEK
PLANTATIONS
0
2
4
6
8
10 Chains
N
TO COUNTY ROAD
PONDEROSA
PINE
THINNING AND
PRUNING AREA
THINNING
CHECK
AREA
RIVER
NATURAL
AREA
OVERWOOD REMOVAL AND PRUNING
SWAMP
PONDEROSA PINE
ALTERNATE WEST. WHITE PINE & WHITE SPRUCE
ALTERNATE WESTERN LARCH & WHITE SPRUCE
WESTERN WHITE PINE
PONDEROSA PINE
PONDEROSA PINE
TRAIL
WEST. WHITE PINE
PONDEROSA PINE
BALKAN PINE
WESTERN WHITE PINE
PONDEROSA PINE
PRIEST RIVER
Benton Creek

MODEL PLANTATION
Area 28

To demonstrate good planting practices, a model plantation was conceived in 1923 and established with great difficulty. But because of a number of causes, none of which is peculiar to this plantation, the planned objective has not been achieved.

In 1922 and 1923 the tract was cut over and the brush piled and burned. Planting started in 1924, but dry windy weather and dry soil forced postponement of the work before its completion. In the 1924 planting, 2-2 western white pine stock was placed 8 x 8 feet. The 5.2-acre block of 8-foot spacing was completed in 1925, as well as a 5.1-acre block of 1-2 white pine spaced 6 x 6 feet. Fail spots in the 6-foot planting were replanted in 1929. An examination of the 1924 planting at the end of one growing season showed approximately 50 percent of the trees alive; a fall examination of the 1925 planting gave a figure of 42 percent survival. Estimated survival for the entire plantation in 1930 was 10 percent. In the late 1930's, ponderosa pine seedlings were planted to replace white pines which had died.

The high mortality was caused by several factors. Climatic conditions affecting seedling establishment in the region are severe, especially on open sites such as Area 28. July and August are normally hot and dry, and consequently seedlings which are not well rooted by July are often killed by drought. In 1925, May and June were moist and plantings appeared to be well established, but July and August were unusually dry and survival was poor. The 1930 study of survival showed the beneficial influence of shade -- almost all of the live seedlings were found in the shade of stumps or logs. Another cause of mortality was the dense sod which formed on the area. Not only did the sod compete with the planted stock for scarce soil moisture, it also attracted livestock that trampled and killed numbers of trees. The burrowing and digging of pocket gophers also undoubtedly destroyed the roots of many seedlings.

Designed as a model of good planting practice, this plantation has instead demonstrated several common obstacles to successful planting. While not insurmountable, they do present serious hindrances to survival and early growth. By planting early and taking advantage of shade cast by logs and stumps the effects of summer drought can be minimized. Plantations should be established before brush or sod invades. Livestock should be excluded. Control of pocket gophers over large areas is often impractical but fortunately they are not as numerous on the slopes -- which comprise most planting sites in this region -- as they are on flats such as the site of this plantation.

LARSEN THINNINGS
(Plots 101, 102, 103, 104)
Area 30

Young stands of timber usually contain many more trees per acre than can possibly survive to maturity. As these trees grow, they compete for light, water, and soil nutrients. The taller, and faster growing trees suppress the smaller and weaker ones. This natural process, although it results in growing mature trees suitable for sawlogs, is slow and wasteful. By removing slow growing, ill formed, and defective trees and perhaps selling them at a profit, selected "crop" trees are given more growing space. The better formed trees of the valuable species, no longer forced to compete so strongly with their neighbors, thereby reach the desired merchantable size in a shorter time.

Area 30 contains four half-acre thinning plots established in 1914 in a 55-year-old stand on a good site. The experiment has been named for J. A. Larsen, second Director of the Experiment Station, who planned and installed the study. The young stand was dominated largely by western white pine and western larch with an understory of western redcedar.

Stand density was reduced chiefly by thinning out smaller trees, although a few dominant trees were also cut. Plot 102 was thinned first in 1914, again in 1924, and a third time in 1934. Plot 103 was thinned in 1914 and 1934, and Plot 104 was thinned only in 1914. Plot 101, the check plot, was not thinned. The material removed was not of sawlog size.

The 1914 thinning reduced the basal area of the three thinned plots to a stocking of 95 square feet (about 46 percent of normal or full stocking) and 450 trees per acre. The unthinned check plot had a basal area of 156 square feet (76 percent of normal stocking) and 1070 trees per acre. The 1944 remeasurements of these plots showed that the board-foot and cubic-foot volumes produced by the unthinned plot were greater than the volumes, including material removed in thinnings, produced by any of the thinned plots. Apparently, heavy thinning reduced the growing stock so greatly that it did not utilize the site completely. Plot 102, which had been thinned three times, gave the best results. A study of similar trees on all four plots showed that the more frequent the thinning the more rapid was diameter growth.

Final conclusions have not been reached, but this and similar experiments indicate that light frequent thinning, lighter than that made in this experiment, enables timber to grow to merchantable size more rapidly and permits improvement of the final crop's composition by removing trees of unwanted species. These thinnings cannot at present be made -- except at a deadweight expense -- because the small trees removed in the thinnings have little market value.

The following tables present some growth statistics on the plots.

Board-Foot Summary for 1914 Thinning Plots

Age in 1914: 55 years Site index: 58 feet (at 50 years)

(Per acre)

Item	101 No thinning	102 3 thinnings	103 2 thinnings	104 1 thinning
	- - - -	- - - - Bd. ft.	- - - -	- - - -
Volume in 1914 after thinning	4,412	2,024	1,780	3,402
Volume in 1944	19,728	16,986	14,170	17,522
Volume removed in thinning	--	1,412	1,690	1,148
Total production 1/	19,728	18,398	15,860	18,670
Periodic mean annual growth 1914-1944	511	527	452	471

Cubic-Foot Summary for 1914 Thinning Plots

(Per acre)

Item	101 No thinning	102 3 thinnings	103 2 thinnings	104 1 thinning
	- - - -	- - - - Cu. ft.	- - - -	- - - -
Volume in 1914 after thinning	3,415	2,155	2,162	2,410
Volume in 1944	7,128	4,806	4,368	5,283
Volumes removed in thinning	--	2,296	2,107	1,659
Total production 1/	7,128	7,102	6,475	6,942
Periodic mean annual growth 1914-1944	124	127	111	96

1/ Total production = volume in 1944 + volume removed in thinning.

1919 THINNINGS
(Plots 105, 106, 107, 108)
Area 31

Merchantable stands of higher value are grown in a shorter time when the more valuable species and better formed trees are favored by thinning. The stand on Area 31, 60 years old in 1919 when it was thinned from below, had about 80 percent of normal basal area stocking. To contrast the effect of thinning intensities, Plots 106, 107, and 108 were thinned to 65, 50, and 38 percent of normal basal area stocking, respectively. Plot 105 was not thinned. Growth data for these plots are summarized in the tables on the next page.

The best growth has occurred on the lightly thinned plot, No. 106. Plots 107 and 108 apparently were thinned too heavily. The results of a single thinning experiment such as the series on Area 31 cannot be regarded as indicating general trends in growth. However, by analyzing the results along with those from other experiments, it has been concluded that light, frequent thinning is best for pole-sized western white pine. Light thinning maintains sufficient growing stock to utilize the productive capacity of the site and frequent thinning prevents competition from appreciably slowing the growth of selected crop trees.

Thinning will not be a good business venture unless there are markets for small trees to justify the cost of thinning. In the past there have been no such markets in the Inland Empire and today there are only a few. But eventually there will be widespread need for the information which is being collected on Area 31 and other thinning experiments.

The cedar understory on these plots showed that this species responds very well to release. Diameter growth of cedar on the thinned plots exceeded that on the unthinned plots by 145 to 200 percent.

Board-Foot Summary for 1919 Thinning Plots

Age in 1919: 60 years Site index: 64 feet (at 50 years)

(Per acre)

Item	105 No thinning	106 Light thinnings	107 Moderate thinning	108 Heavy thinning
	Bd. ft.			
Volume in 1919 after thinning	11,270	12,540	11,220	9,444
Volume in 1944	27,770	32,852	27,564	22,568
Volume removed in thinning	--	120	1,992	4,534
Total production 1/	27,770	32,972	29,556	27,102
Periodic mean annual growth 1919-1944	660	812	654	523

Cubic-Foot Summary of 1919 Thinning Plots

(Per acre)

Item	105 No thinning	106 Light thinning	107 Moderate thinning	108 Heavy thinning
	Cu. ft.			
Volume in 1919 after thinning	4,876	4,310	3,374	2,685
Volume in 1944	7,253	7,987	6,606	5,171
Volume removed in thinning	--	729	1,822	2,030
Total production 1/	7,253	8,716	8,428	7,201
Periodic mean annual growth 1919-1944	95	147	129	99

1/ Total production = volume in 1944 and volume removed in thinning.

KEMPFF THINNING
(Plot 111)
Area 32

In the Larsen and 1919 thinnings (Areas 30 and 31), the larger trees of the more valuable species were selected as crop trees. Growth of these selected crop trees was encouraged by removing competitors. As such thinnings mainly remove trees too small to be sold under present market conditions, the method is usually impractical for forest owners. It requires a large investment with no expectation of returns for a number of years. In contrast, the selection, or Borggreve, thinning method applied on Area 32, in which the largest trees of the stand were cut as well as smaller trees which will soon die, yielded an immediate income. Many of these larger trees were rather limby and their removal allowed the better formed smaller trees to develop more rapidly.

The selection thinning experiment on Area 32 was established in 1925 in a thrifty, well stocked 62-year-old stand on an excellent site. Ten thousand board feet (54 percent of the stand) were cut as a commercial operation from the one-acre plot, by cutting the largest white pine and larch trees. A number of small trees of no market value, injured in logging also were removed from the stand. The basal area composition was changed from 48 percent to 54 percent white pine, 32 percent to 23 percent larch, and 20 percent to 23 percent other species. Because the area of the stand was so limited, an uncut check plot for comparison with the thinned plot was not established.

The test has been named for Gerhard Kempff, superintendent of the Forest, who supervised establishment of the study.

Remeasurement of the plot in 1946 showed that the total production -- volume removed plus volume on the plot in 1946 -- was less than the expected volume had the plot not been thinned. Future thinnings of the stand should probably aim at favoring the growth of selected crop trees by removal of smaller competing trees. A repetition of the selection thinning would remove so many of the larger, faster growing trees that total growth of the stand probably would be reduced excessively.

One of the better features of selection thinning is the realization of an early return. At the same time, if the cutting is not too heavy, a vigorous stand of well formed trees can be left for future growth and subsequent cuts. Selection thinning is not adapted to low vigor stands because, with the few vigorous dominant trees removed, the remaining stand would have a poor chance for satisfactory future growth.

Summary for
Kempff Thinning Plot 111

Age in 1925: 62 years **Site index: 70 feet (at 50 years)**

(Per acre)

	Plot 111 volumes		Estimated 1/ yield in similar uncut stand	
	Cubic Cu.ft.	Scribner Bd.ft.	Cubic Cu.ft.	Scribner Bd.ft.
Volume in 1925 before thinning	6,173	18,580	6,173	18,580
Volume removed in thinning	2,356	10,030	--	--
Volume in 1925 after thinning	3,817	8,530	6,173	18,580
Volume in 1946	6,798	24,160	9,440	38,500
Total production 2/	9,154	34,190	9,440	38,500

1/ Yield estimated assuming no change in stand density. "Second-growth, yield, stand, and volume tables for the western white pine type", U.S.D.A. Tech. Bull. No. 323 used to predict yields.

2/ Total production = volume in 1946 + volume removed in thinning.

UPPER BENTON CREEK THINNINGS
(Plots 157, 158, 159, 160, 161)
Area 33

The Upper Benton Creek thinning plots on Area 33 were established in 1933 with the aid of CCC's to study the effect of different intensities of thinning from below in a 75-year-old stand. Before thinning, the stand was well stocked, chiefly with white pine. The site, a north slope, is good for white pine. Composition of the stand was improved by removing a large number of the less valuable trees, mainly Douglas-fir and hemlock as well as some western redcedar. Poorly formed trees of all species were cut. Trees cut were largely below sawlog size. The thinning was expected to encourage growth of the larger, better formed trees of the more valuable species.

Stand density on Plot 157, the most heavily thinned, was reduced to 49 percent of normal basal area stocking. Plot 158 was thinned to 58 percent of normal, and Plot 159 to 62 percent of normal. Plot 160 was thinned to give an overwood of the same density as Plot 158, but all of the redcedar understory was removed to test whether or not growth of the overstory would be influenced; this treatment reduced the stocking to 55 percent of normal. Plot 161, with 89 percent of normal stocking, was left unthinned.

Summaries of the plot volumes for the first 10 years after thinning are presented on the next page.

On the basis of 10 years' growth, the moderate and heavy thinnings were too severe. So many trees were removed that the remaining ones did not fully utilize the growth potential of the habitat. The thinnings in this 75-year-old stand have not resulted in increased growth. However, so short a period may not fully show the effectiveness of the methods. The quality of the stand has been improved by the removal of some of the low value species and poorly formed trees.

Diameter growth of the redcedar understory was summarized in 1938. The most rapid growth -- 0.48 inches in five years -- occurred on the heavily thinned plot, No. 157. Redcedar growth averaged 0.45 inches on Plot 158, 0.40 inches on Plot 159, and 0.36 inches on the unthinned plot. The findings clearly indicate that western redcedar can respond quickly to increased growing space.

Summary of Board-Foot and Cubic-Foot Volumes
Upper Benton Creek Thinnings
(Plots 157, 158, 159, 160, 161)

(Per acre)

Age in 1933: 75 years

Site index: 62 feet (at 50 years)

Item	Scribner volumes				
	161 Unthinned	159 Light thinning	158 Light thinning	157 Heavy thinning	160 Light thinning, plus removal of cedar understory
			Bd.ft.		
Volume in 1933, after thinning	25,816	24,908	18,416	16,592	23,456
Volume in 1943	33,252	31,456	24,884	21,624	29,264
Volume removed in thinning	-	2,276	1,956	7,016	2,348
Total board-foot production	33,252	33,732	26,840	28,640	31,612
Periodic mean annual growth, 1933-43	744	655	646	503	580

Item	Cubic volumes				
	161 Unthinned	159 Light thinning	158 Light thinning	157 Heavy thinning	160 Light thinning, plus removal of cedar understory
			Cu.ft.		
Volume in 1933, after thinning	7,660	5,896	5,144	4,356	5,476
Volume in 1943	8,820	7,196	6,732	5,356	6,432
Volume removed in thinning	-	1,412	1,208	2,660	1,544
Total production	8,820	8,608	7,940	8,016	7,976
Periodic mean annual growth, 1933-43	116	130	158	100	96

CANYON CREEK THINNINGS
(Plot 179)
Area 34

About 1857 a large forest fire swept across much of Benton Creek and most of Canyon Creek. In spots on Canyon Creek the fire burned hard but draws and other moist places were sometimes skipped completely and many trees, though fire scarred, were left standing and alive. These survivors showered the burn with seed. The result was a stand of young growth so dense that few trees had room for good development. Remnants of the parent stand, usually fire scarred and defective, shaded the young growth, further suppressing it and favoring the shade-tolerant species -- western redcedar, western hemlock, and grand fir. Crowns of most of the larch, pinched to wisps, were attacked by mistletoe. The dense stagnated young growth and defective remnants of the old stand have earned for the area the term, "Canyon Creek Jungle." One forester has called the area a "silvicultural mess."

Various ways have been suggested to make the area more productive. The most extreme proposal has been to burn off the present stand and plant young trees. A more frequent suggestion has been to thin the stands in order to give the trees room to grow. Another suggestion has been to wait until products can be harvested and then to improve the growing stock through harvest cuttings.

While CCC labor was available, cuttings were tried to improve the condition of the stand in Area 34. A heavy thinning from below, combined with improvement cutting, was made in the winter of 1938-39. Hemlock under six inches and all defective trees except white pine were cut and the understory thinned to favor the cedar. Some larger hemlock in the overstory were also cut. About 25 acres were thinned in five 200-foot strips, alternating with five unthinned strips, each 130 feet wide. The strips start at the creek bottom and extend up the slope a distance of 660 to 1000 feet. Thirty-six sample plots, one-tenth of an acre in area, are located within the strips.

Before thinning, the stand averaged 230 square feet of basal area per acre; thinning reduced density to 147 square feet. Species composition by basal area before and after thinning was:

	Before (Percent)	After (Percent)
Western white pine	12	16
Western larch	32	44
Douglas-fir	1	1
Grand fir	2	2
Western hemlock	28	14
Western redcedar	25	23
Total	100	100

The stand improvement was costly in man days. Even though the stand has benefited from the work, the benefits probably will not equal the cost. This and other similar stand improvement tests lead to the belief that the best practice is to let the stands grow until usable products can be economically harvested. Commercial cuttings can then improve growing conditions and composition. Although this practice will not obtain maximum growth, it appears to be the only way to handle a difficult situation at reasonable cost at the present time.

CENTER RIDGE THINNINGS
(Plots 180 and 181)
Area 35

Up the slope from Area 34, and similar to it, is another series of thinned and unthinned strips. The stand of Area 35 is also dense and slow growing with a small proportion of white pine. Area 35 is made up of two units: The western unit contains four 200-foot thinned strips alternating with four 130-foot unthinned strips; the eastern unit contains two thinned and two unthinned strips. Both thinned and unthinned strips start at the roadside and extend up the slope variable distances from 660 to 1000 feet. The six thinned strips contain about 18 acres.

The thinnings in Area 35 emphasized release of western redcedar. On each unit, the lower 200 feet of one thinned strip was heavily thinned. The overstory was removed and the understory thinned to leave approximately 400 vigorous and well formed western redcedar per acre. On the remainder of these strips and on the other thinned strips, defective overstory trees were cut and the understory thinned to favor 200 to 400 of the best western redcedar per acre.

A one-tenth acre sample plot was established in each strip to measure results of thinning.

Growth of the cedar understory was studied in the spring of 1950 by means of increment borings. Average growth was as follows:

Treatment	Average growth in diameter at 4.5 feet for 10-year period	
	Before thinning	After thinning
	Inches	Inches
Unthinned	1.1	1.1
Understory thinned to 200 to 400 cedars per acre	1.2	1.4
Understory thinned to 400 cedars per acre and overstory removed	0.9	2.7

Evidently the overstory provided most of the competition for the cedar understory. The study showed the cedar responded very well to release from overwood competition.

Although the Center Ridge thinnings were too costly to be practical, they have encouraged efforts to obtain similar results less expensively. On the tract to the west -- bounded by Area 35, the road, and the ridge top -- the larch overstory was sold and logged as poles in an attempt to release the cedar understory. Most of the larch were infected with mistletoe and were growing slowly. The benefit to the cedar understory will not be as great as on Area 35 where the entire overstory was removed, but growth should be increased and at no cost.

PRUNING TESTS
(Plots 177, 178, 182)
Area 41

The pruning test on Area 41 was designed to determine if wood-decaying organisms enter through pruning wounds. Sixteen ponderosa pine trees were pruned on Plot 177, eight in the fall of 1938 and eight in the spring of 1940. The branches on each selected tree were pruned with a saw by two methods: (1) Severing limbs two inches from the bole, and (2) cutting flush with the bole of the tree. Two or more whorls of branches on each tree were pruned by each method, but only one method was tested on the branches in a particular whorl. A similar test was established on Plot 178 in a pole stand of white pine in the Knoll Area, No. 51, and two more trials were made in white pine stands on the Deception Creek Experimental Forest. As almost all of the pruning wounds are now healed over, the trees will be dissected within a year or two and the wood back of each pruning scar examined for decay.

The trees from the pruning experiments have already provided information on the rate of wound healing. Findings summarized in Station Research Note No. 45 indicate that optimum conditions for rapid healing result from closely pruning small live branches on rapidly growing trees.

IDA CREEK PRUNING AREA
Area 42

The 100-acre Ida Creek pruning area contains alternate strips of pruned and unpruned trees. The three most northerly pruned strips are in a 21- to 60-year-old ponderosa pine stand. The other strips contain mainly western white pine in the 60- to 80-year class, with other age classes occurring in spots.

During the winter of 1939-40, 2810 ponderosa pines and 7550 white pines were pruned by CCC's using saws. Height of pruning ranged from 7 to 18 feet. Only dominant and codominant, well formed, sound, vigorous trees were pruned. Not more than one-third of the live crown length was removed from any tree. Pruning slash was left where it fell.

When the timber is harvested a mill tally of lumber cut from pruned and unpruned trees is planned to compare the yield and grade of lumber.

DEFECTIVE TREE DISPOSAL
Area 45

Residual stands, left after logging mature timber, present a serious forest management problem in northern Idaho. The residual stands often contain many suppressed, defective, poorly formed, low value hemlock or grand fir. The cover is often too dense to permit reproduction of more valuable kinds of trees. If the residual stands contain sufficient vigorous, sound, desirable trees, release or thinning and sanitation cutting may create conditions favorable to further growth. In the Area 45 project, three cut-over stands on the western edge of the Forest have been subjected to sanitation cutting.

A 12-acre tract adjacent to the boundary of the Forest and the East River was logged in 1919, leaving a mixed stand composed principally of unmerchantable trees. Scattered through the stand were sound and thrifty trees. During the winter of 1939-40, badly defective trees and many of the understory hemlock and poorly formed cedars were felled by CCC's. Snags were felled as a fire hazard reduction measure. The slash was piled and burned.

The second portion of Area 45 is enclosed by a horseshoe bend of Priest River. The original stand was reserved from the 1910 Jurgens Flat cutting as a seed block and was logged at a later date. This cutting left scattered 40- to 80-year white pine and other trees interspersed with large openings. During the 1930's several improvement operations were conducted in this stand. These measures included cutting defective trees, burning slash to reduce the fire hazard, and pruning the better white pine and ponderosa pine trees.

The third part of Area 45 is located in the extreme southwest corner of the Forest. Down timber, old slash, and snags were piled and burned in 1939. The following year defective trees were eliminated.

As a result of the stand improvement measures which have been described, the timber on the Area 45 units is now reasonably thrifty and productive.

An interesting relic of an almost discontinued logging method -- an old logging flume -- can be seen along Big Creek in this third area. The flume, about six miles long, was constructed by the Diamond Match Company in 1924 and operated until approximately 1935 during the logging of Big Creek. Water was fed into the head of the flume. Logs, skidded in chutes and then rolled into the flume, floated into the river and were driven downstream.

JURGENS FLAT CLEAR CUTTING

Area 50

Jurgens Flat was cut in 1910, a year before the establishment of the Experimental Forest. At that time little was known of the silvical requirements of western white pine and associated tree species. Hence, foresters based their silvicultural recommendations upon observation of natural events such as the reseeding of burns. The conclusions, only in part valid, may be summed up as follows:

1. Western white pine readily restocks denuded areas to distances up to one-half mile.
2. Western white pine is not windfirm and can be left safely only in uncut strips or blocks.
3. Overhead shade favors reproduction of grand fir and western hemlock over the more desirable western white pine.
4. A mineral seed bed is required for best germination.

These conclusions led to recommending clear cutting in blocks or strips and broadcast burning slash. The Jurgens Flat cutting was one of these clear cuttings with reserve seed tree blocks. It included tracts on both sides of Priest River and covered 320 acres. The portion east of the river is now within the Experimental Forest. The stand was overmature at the time of cutting. After merchantable timber was removed, the remaining trees were felled. The debris from logging and sanitation cutting was broadcast burned after clearing strips 75 to 100 feet in width around reserve blocks. Reserve blocks ranged in area from 1 to 20 acres and were spaced at intervals in some instances as far apart as one-fourth mile. The timber on the Knoll Area, No. 51, is a remnant of one of these seed blocks.

A survey in 1912 disclosed that reproduction was satisfactory only within a few hundred feet of reserve seed tree blocks. A tally of reproduction 20 years after logging gave the figures in the following table:

Distance from seed block (feet)	Established seedlings per acre		
	Western white pine	Other species	Total
	- - - - - - - - -	Number	- - - - - - - - -
0 - 200	2,300	12,300	14,600
201 - 400	870	830	1,700
401 - 600	320	280	600
601 - up	100	200	200

Reproduction was unsatisfactory on areas more than 400 feet from the nearest seed plot. The 600 seedlings per acre found 401 to 600 feet from seed blocks are not sufficient for satisfactory stocking.

Failure to obtain satisfactory regeneration was due to two causes: (1) The seed blocks were too widely spread to allow sufficient seed to be disseminated over the area, and (2) the exposed flat is a severe site and areas at a distance from the seed blocks received no protection from the standing timber.

Clear cutting with seed blocks was practiced, especially in the Kaniksu district, from 1909 to 1912. Marking rules that were adopted for white pine stands in 1913 specified clear cutting and placed dependence upon seed in the duff for reseeding. Increasing knowledge gained by experience and research resulted in revision of the rules in 1916 to prescribe the scattered seed tree system for mature western white pine. The 1916 rules, with some modifications, were followed until after 1940 when new problems arising from widespread occurrence of white pine blister rust forced a departure from the seed tree method. New marking rules were written in 1947 adopting cutting methods which aid in blister rust control. These rules specify light partial cutting, where possible, and clear cutting followed by broadcast burning of slash, and planting in other instances.

The Jurgens Flat cutting has provided much basic information on regeneration of western white pine. In addition, the area has been used for planting studies. Several plantations of western white pine, eastern white pine, ponderosa pine, and Norway spruce are to be seen here.

KNOLL AREA
Area 51

The Knoll Area, which is partly covered with overmature white pine forest and partly with young growth that originated after the clear cutting in 1910 (described under Area 50), contains several plots.

Overmature Virgin Stand

Plot 148 is a two-acre yield plot containing overmature forest that is a remnant of a seed block left in 1909. The seed block, with the exception of what is now Plot 148, was thinned in 1921 and wholly cut in 1939. The stand on Plot 148, more than 250 years old, is overmature and the composition is slowly changing. The shade-tolerant western hemlock and western redcedar, which during early life of the stand were generally suppressed, are gradually being released by the death of western white pine and Douglas-fir. Western larch, although very intolerant of shade, is long-lived and has maintained its dominant position in the stand, but it too will eventually disappear.

This stand illustrates how natural forest succession replaces the sub-climax white pine with a less commercially valuable climax forest composed largely of hemlock and cedar. Natural events, principally lightning fires, have in the past periodically set back development of climax forests. Otherwise, north Idaho forests would have contained little white pine at the time of settlement. Recognition that the natural ecological successional trend must be arrested in order to continue production of white pine is a fundamental research contribution to white pine forest management.

Trenched Quadrat

Plot 148-A, installed in 1930, is a replication of earlier experiments in other regions and Europe which demonstrate that light is not the only factor influencing the survival of plants. Two quadrats, 6.6 feet on a side, were located in the overmature virgin stand of Plot 148. Each quadrat contained a small number of herbaceous plants. Conifer reproduction was absent. A trench 40 inches deep and 8 inches wide was dug around one plot to sever the roots of surrounding vegetation and was then filled. The trench was re-dug at each examination of the plot from 1931 through 1936 and again in 1945. The other quadrat was left undisturbed. Sixty seeds each of western white pine, western hemlock, western larch, and grand fir were planted in each quadrat. Germination of this seed was uniformly poor; a total of 7 coniferous seeds germinated on the untrenched quadrat while on the trenched plot a total of 14 seeds germinated. Only one seedling, a grand fir on the trenched plot, survived for more than three years. However, secondary vegetation has demonstrated the influence of root competition better than the germination, growth, and survival of conifers. On the trenched plot shrubby and herbaceous plants have increased greatly in vigor and numbers. These plots show clearly that the growth of the secondary vegetation was limited, at least in part, by soil moisture.

Reproduction Development

Plot W-67, 0.1 acre in area and located northwest of the old-growth stand of Plot 148, is tracing the development of a juvenile forest of white pine and associated species. It is one of a large number of similar plots established in young stands of various compositions on a variety of sites and exposures. Information on the relative growth rates of different trees of the region and the struggle for dominance in early years is of great practical value for management of young stands. Results are not yet ready for publication.

Pruning Experiment

Plot 182 was established in Area 51 to determine the height to which western white pine trees can be pruned without seriously retarding growth. The trees at the time of pruning in 1940 were 15 to 25 years of age and were growing in a moderately open stand. Diameters at breast height ranged from 3.2 to 8.5 inches and total height from 21 to 46 feet. Twenty paired trees, alike in d.b.h., height, and crown characteristics were selected. One tree in each pair was pruned and the other left as a check. Pruning ranged in severity from one-fifth to two-thirds the live crown length.

Results at the end of the first five years of this and two similar tests at other locations are given in Station Research Note No. 41. The experiments showed that:

1. Removal of about 50 percent of the live crown appeared to be the safe limit from the standpoint of serious mortality.

2. Pruning one-third or less of the live crown caused no appreciable reduction in rate of height growth, but greater live crown removal resulted in seriously decreased height growth.

3. Pruning caused a greater reduction in diameter growth than in height growth. Removing one-fifth of the crown caused a small temporary reduction in growth, but the growth rate had recovered at the end of five years.

The findings indicate that not more than one-third of the live crown should be removed at one time.

KOCH CUTTING TEST
(Plots 139, 140, 142)
Area 52

Area 52 contains three experimental plots designed to measure the establishment and growth of white pine reproduction under three densities of residual timber. The three degrees of forest cover were created by logging merchantable timber, except for scattered white pine seed trees, and by felling enough unmerchantable residual trees to thin the remaining trees to the densities desired. The experiment is an attempt to solve the troublesome silvicultural problem created by the unmerchantable, defective, and undersized trees, chiefly hemlock and grand fir, which are left when white pine is logged. The residual trees reseed cut-over white pine land heavily with undesirable species and their shade tends to suppress white pine reproduction.

The experimental plots have been named for Elers Koch, long-time Chief of Timber Management, Northern Region, United States Forest Service, who suggested the test and helped install it.

The overmature stand on Area 52 was logged in 1924 and 1925, leaving scattered white pine seed trees as well as unmerchantable trees of all species. On Plot 139, the most westerly, almost all unmerchantable residual trees except about 20 thrifty white pine, hemlock, and western redcedar per acre were felled; slash was piled and burned along with logging debris in 1927. No residual trees were cut either on Plot 140, which logging left with only a moderately dense tree canopy, or on Plot 142, the most easterly, which was retained with a dense residual tree cover.

Plot	Residual trees per acre in 1927	Percent of full sunlight beneath tree canopy
139	20	80
140	230	50
142	884	7

The white pine seed trees were harvested in 1939.

Germination was adequate for full stocking of white pine and other trees on all three plots, and survival of seedlings was satisfactory on both the open plot (No. 139) and the half-shade plot (No. 140). But under the dense shade of Plot 142, the strongly intolerant western larch and moderately tolerant white pine and Douglas-fir could not survive. Though much less than on Plots 139 and 140, seedling survival of the shade-tolerant grand fir, hemlock, and western redcedar was sufficient on Plot 142 to fully stock the ground to these species.

Growth of reproduction on the three plots differs strikingly. Fast growing western larch and lodgepole pine dominate the stand on Plot 139. Not far behind in height are western white pine, Douglas-fir, and grand fir, while western hemlock and western redcedar occupy the lowest position. Although white pine has been able to maintain itself in this situation, overtopping and strongly competing trees should be weeded out to increase the proportion of white pine in the final stand.

Under the half shade of Plot 140, all species have been able to persist but they have not grown as well as in the more open Plot 139. Grand fir and western hemlock have grown just a little faster than white pine and Douglas-fir. The intolerant larch and moderately tolerant white pine and Douglas-fir are being eliminated except in larger openings where they receive more light. In order to favor white pine, the overwood should have been removed 15 to 25 years after logging and the reproduction weeded. Without weeding, white pine, Douglas-fir, and western larch are steadily declining and eventually they will comprise only a very minor portion of the new forest.

On Plot 142 insufficient light has permitted only a few grand fir, hemlock, and cedar to survive and they are persisting as very small trees, awaiting a chance to grow if openings occur. Other kinds of trees have disappeared.

A re-examination of the plots in 1941 showed that the residual trees are deteriorating. The heavier the cutting the greater the subsequent deterioration. Grand fir and white pine have been sun scalded on Plots 139 and 140. Other injuries found on these two plots included yellowing and drying of cedar foliage, and breaking of tops by wind and snow. Many of the large hemlocks were dying back from the top. The denser timber on Plot 142 showed less sun scalding, yellowing, and drying but considerably more snow breakage.

Partial elimination of unmerchantable residual timber has been rather widely practiced as a sale area betterment measure on national forests. Since about 1942, the increasing demand for lumber from grand fir and hemlock has lessened the problem of clearing away the old forest in order to regenerate white pine. Today, loggers can better afford to cut reasonably sound mixed timber along with the pine. But the badly defective and undersize trees still must be eliminated if the land is to be quickly restocked with thrifty reproduction of the more desirable kinds.

The Koch plots are but three of a large number of similar plots which the Station has established to study the basic requirements of each species and the cutting methods for proper management of western white pine type.

GROWTH AND YIELD OF WESTERN WHITE PINE
Area 60

Every forest manager who wants sustained production from his timber needs to know how fast it is growing. He needs growth information to determine when timber should be cut and how much timber can be cut without depleting the growing stock. Area 60, which includes permanent sample plot No. 118, is part of a project aimed at solving problems of growth in white pine stands.

Foresters have a number of methods for determining the growth of forest stands. For short-time predictions, they sometimes take cores from trees by means of an increment borer. Past annual growth of a tree can be seen and is measured on the core and this growth rate, or trend, can be projected into the future.

Another common method is to measure the timber on a number of small temporary sample plots which are located in a wide range of age classes and site quality classes. Tables are derived from these measurements which show average stand volumes and other statistics by age classes and site quality. These can be used to predict the growth of timber. Such tables have been prepared for the western white pine type and published as U. S. Department of Agriculture Technical Bulletin No. 323, "Second-growth yield, stand, and volume tables for the western white pine type", by I. T. Haig, 1932.

The surest method of learning about growth of stands is by periodic remeasurement of permanent sample plots. Plot 118 is one of many plots which the Experiment Station has established throughout the white pine forests in order to measure actual growth at intervals. Established in 1925, Plot 118 is one-tenth acre in size. Each tree 0.6 inches and greater in diameter at breast height has been numbered and identified with a metal tag. The plot is examined at five-year intervals at which time detailed measurements and observations are made for each tree.

In addition to Plot 118, six other permanent yield plots, Nos. 112, 113, 114, 117, 148, and 151, are located on the Experimental Forest in western white pine type; and four plots, Nos. 115, 116, 122, and 123, in western larch -- Douglas-fir type.

SUMMARY DATA FOR PLOT 118
(Per acre)

Age in 1925: 67 years | Site index: 66 feet (at 50 years)

(Includes all trees 0.6 inches d.b.h. and larger)

Species	Trees		Basal area		Total volume		Scribner volume	
	1925	1950	1925	1950	1925	1950	1925	1950
	- - -Number- - -		- - - Sq.ft. - - -		- - - Cu.ft. - - -		- - - Bd.ft.- - -	
Western white pine	414	303	163	197	5829	8386	23,071	38,646
Western larch	30	30	16	21	458	695	1,081	1,768
Douglas-fir	192	71	71	69	1850	2268	4,919	9,697
Western hemlock	30	20	1	1	7	15	0	0
Western redcedar	666	646	23	45	258	710	0	0
Lodgepole pine	10	0	3	0	508	0	0	0
All species	1342	1070	277	333	8910	12,074	29,071	50,111
Percent of normal	165	247	116	117	117	103	112	92

WEIDMAN ARBORETUM
Area 61

An area of about 100 acres was set aside in 1929 as an arboretum to be planted with native and exotic tree species. The aim was to establish small stands of various trees to test their adaptability to the climate, and to provide examples for educational purposes. Forty-six blocks have been planted. These are shown on the map of the arboretum area on the following page. Although formerly a good site for tree growth, the difficulties encountered in establishing trees and the slow growth of those established indicate that the many years of exposure following logging in 1910 and several successive fires have resulted in deterioration of the habitat.

The arboretum has been named after R. H. Weidman, third Director of the Northern Rocky Mountain Forest and Range Experiment Station, who planned the arboretum and personally supervised most of the plantings.

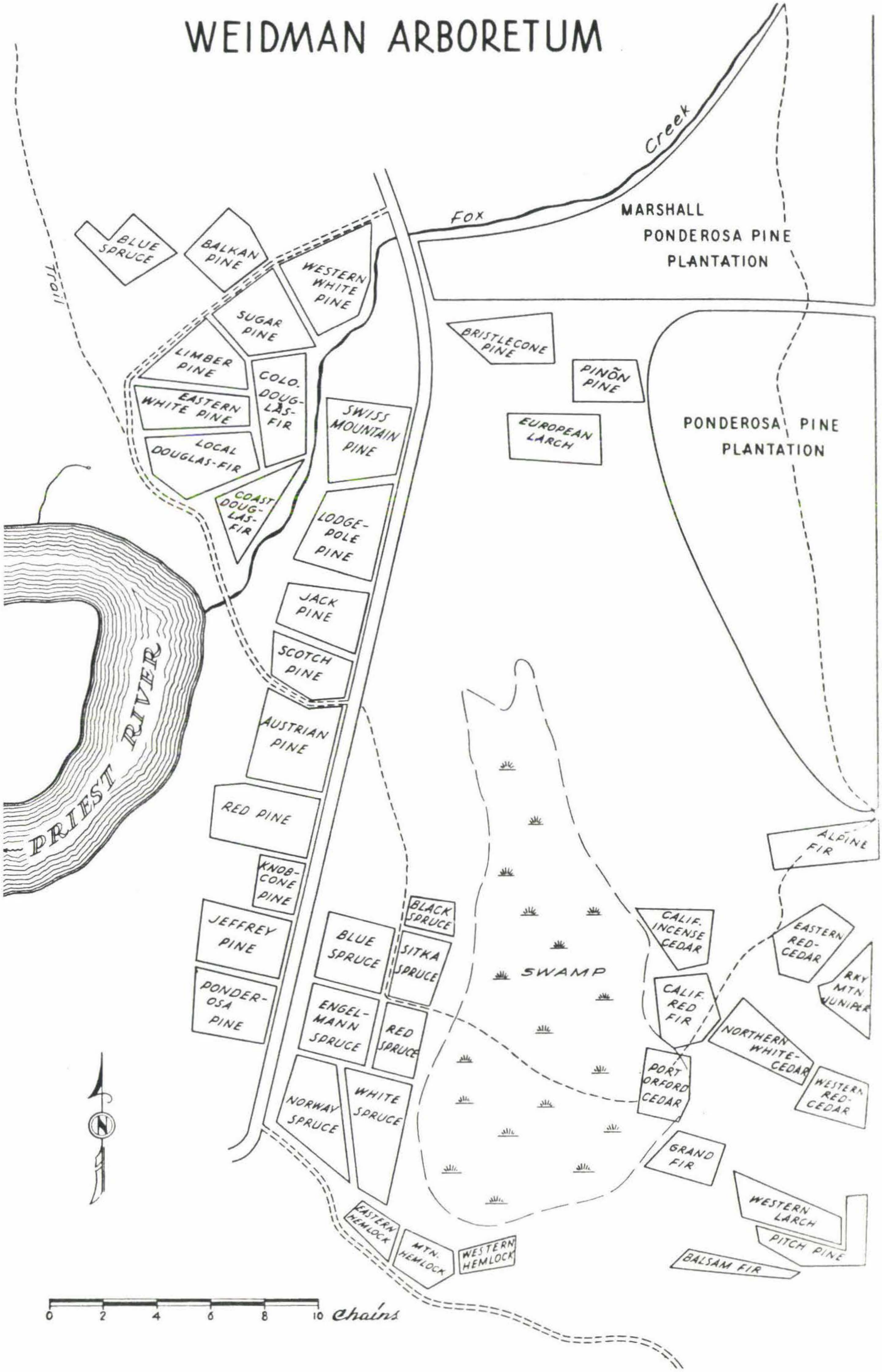
Since shortly before World War II the arboretum has received little care because of reduced operational facilities on the Experimental Forest and the demands of other research problems. Corner posts bearing metal tags identifying the species in each block were set at the time of planting. Visitors to the arboretum should use the map and these corner posts, most of which are standing, to identify the species.

Several blocks are of unusual interest. Jack pine (Pinus banksiana), native to the northeastern United States and Canada, and Colorado blue spruce (Picea pungens), from the high mountains of the central Rockies, have grown very well. European larch (Larix decidua) has thrived. Generally hemlock and cedar have failed. Macedonian white pine (Pinus peuce), a five-needle pine and hence susceptible to white pine blister rust, has resisted the disease considerably better than a nearby block of western white pine. Jeffrey pine grew well until severely damaged during a cold spell in January 1949.

The Brewster plantations, Area 25, contain several well marked blocks of exotic trees which should be visited by those interested in studying the growth of exotics in this region.

The extreme eastern portion of the arboretum contains 10 acres of planted ponderosa pine, Cabinet National Forest seed source. The heavy shrub cover, mainly Ceanothus velutinus, was removed in the spring of 1941 immediately before planting with 2-2 nursery stock. Survival and growth have been good.

WEIDMAN ARBORETUM


Fox Creek
MARSHALL PONDEROSA PINE PLANTATION
Trail
BLUE SPRUCE
BALKAN PINE
WESTERN WHITE PINE
SUGAR PINE
LIMBER PINE
COLO. DOUG-LAS-FIR
EASTERN WHITE PINE
LOCAL DOUGLAS-FIR
COAST DOUG-LAS-FIR
SWISS MOUNTAIN PINE
LODGE-POLE PINE
JACK PINE
SCOTCH PINE
AUSTRIAN PINE
RED PINE
KNOB-CONE PINE
JEFFREY PINE
PONDER-OSA PINE
PRIEST RIVER
BRISTLECONE PINE
PIÑON PINE
EUROPEAN LARCH
PONDEROSA PINE PLANTATION
BLACK SPRUCE
BLUE SPRUCE
SITKA SPRUCE
ENGEL-MANN SPRUCE
RED SPRUCE
NORWAY SPRUCE
WHITE SPRUCE
EASTERN HEMLOCK
MTN. HEMLOCK
WESTERN HEMLOCK
SWAMP
ALPINE FIR
CALIF. INCENSE CEDAR
EASTERN RED-CEDAR
RKY MTN. JUNIPER
CALIF. RED FIR
NORTHERN WHITE-CEDAR
PORT ORFORD CEDAR
WESTERN RED-CEDAR
GRAND FIR
WESTERN LARCH
PITCH PINE
BALSAM FIR
N
0
2
4
6
8
10 Chains

RACIAL VARIATION IN PONDEROSA PINE
(Plot 162)
Area 62

The purposes of the study on Area 62 as stated at its start in 1911 are as follows:

1. To determine the suitability of ponderosa pine seed from different sources for planting in northern Idaho.

2. To ascertain heritable characteristics of growth, form, and hardiness developed through adjustment of parents to local climates.

3. To determine what limitations should be placed on the interchange of seed between localities of different climate.

The study, one of the earliest of its kind in the United States, contains trees from seed collected in 22 different localities in Oregon, California, Idaho, Washington, Montana, South Dakota, Colorado, Arizona, New Mexico, and Utah. Corner posts of the plots show the place of seed origin and the year of plot establishment. Trees were uniformly spaced 5 x 5 feet apart.

The trees show distinct inherited variations. Trees from sources west of the Continental Divide in the north Pacific and northern Rocky Mountain regions have relatively long, slender, flexible needles commonly in bundles of three. Trees from east of the Continental Divide and Colorado and Utah have stiff, thick needles, commonly in bundles of two. Trees from the Arizona-New Mexico plateau have needles of intermediate length and slenderness, preponderantly in bundles of three. These pronounced differences in foliage are the same in trees of the parent localities, indicating that the characteristics are heritable.

Trees that originated in localities within the northern Rocky Mountains, where climate is similar to that at the site of the experiment, have grown the most in height and diameter. Those from Colorado, Utah, Arizona, and New Mexico have grown the least. Comparison of the trees in this test with trees growing in parent localities shows strong inheritance of growth rate in the new environment, except that the tendency is less marked where the trees originated in a more favorable climate.

Relative degree of hardiness to cold was revealed by an extraordinarily sudden 57-degree-F. drop in temperature on December 15, 1924. Two groups of trees from the mild Pacific Coast region were practically eliminated, but trees from rigorous climates suffered little or no loss.

The findings to date have shown that trees from local sources are best for artificial reforestation, and have indicated that the most suitable general territory in which to collect ponderosa pine seed for northern Idaho extends from the Colville district in Washington to beyond the Continental Divide in Montana and from the Salmon River to the Canadian boundary. Introductions from the Pacific Coast are subject to loss from Idaho's sudden and severe temperature changes. Although trees from the Black Hills, southeastern Montana, and Colorado can withstand the climate of northern Idaho, their very slow growth rates make them unsatisfactory planting stock.

Results of this experiment have been published as follows:

> "Non-indigenous western yellow pine plantations in northern Idaho", Northwest Science, Vol. 2, by G. Kempff, 1928.
>
> "Improvement of forest trees", U. S. Department of Agriculture Yearbook for 1937, by E. J. Schreiner. (See pages 1271-1273.)
>
> "Evidences of racial influence in a 25-year-test of ponderosa pine", Journal of Agricultural Research, Vol. 59, by R. H. Weidman, 1939.

Additional reports will be published when further heritable differenc among geographic races are discovered.

PROLIFIC WHITE PINE SEED TREE
Area 63

The subject on Area 63 is a single western white pine tree! This tree, of good vigor, 55 inches in diameter at 4.5 feet above the ground and about 400 years old, may be the champion seed producer in the white pine region. The large number of cones in its upper branches first attracted notice to the tree in 1935. Then approximately 600 cones were counted. Estimates of subsequent cone production were made in the following years:

Year	Estimated number of cones
1935	600
1936	140
1941	750
1942	16
1943	578
1945	80
1946	850
1947	110
1948	200
1949	225
1950	17
Average	324

According to records, 40 cones per white pine is considered a good crop; 100 cones per tree is unusual. The 324-cone average of this tree for 11 years during a 16-year period is remarkable. Observations from 1908 to 1936 indicated that a good white pine seed year may be expected in northern Idaho every three or four years. The tree on Area 63 produced good crops in 9 years out of the 11 observed. Both 1942 and 1950, when the tree bore but few cones, were poor white pine seed years throughout the Kaniksu Forest.

Studies have shown a definite relation of cone production to certain tree characteristics, specifically crown class, vigor, diameter, and age. About 99 percent of the total crop has been found to be produced by dominant and codominant trees. Trees of good vigor begin heavy seed production at diameters of about 14 inches and produce cones more abundantly and frequently than do trees of poor vigor. Trees under 70 years of age are seldom good seed producers, but above 90 or 100 years the productivity of trees appears to depend more upon individual vigor and diameter than age. Some trees may also be genetically superior seed producers.

POLE BLIGHT OF WESTERN WHITE PINE
Area 64

Pole blight is a rather recently discovered disease of pole-size western white pine trees about 40 to 100 years in age. It seems to attack trees of any vigor or crown class and kills them slowly over a period of years. White pine is generally believed to be the only susceptible species, although somewhat similar symptoms have been found on trees of two or three other species. Damage was first observed in the late 1920's, but at that time it was not recognized as a specific disease. The cause of pole blight is unknown. Several agencies are studying the disease and considerable progress has been made toward determination of the cause. A survey made by the Division of Forest Pathology in 1950 showed that pole blight has caused moderate to severe damage in 56,000 acres of pole-size timber. It has been found in all parts of the western white pine type in the Inland Empire except the district in or near the Clearwater National Forest. Several stands on the Priest River Experimental Forest have been badly damaged by pole blight, especially in Ida Creek, Canyon Creek, and Benton Creek. The most severe damage,first noticed in 1938, has occurred in Area 64 on Canyon Creek.

The most noticeable symptom of pole blight is a yellowing of the foliage on groups of white pine trees or of isolated individuals. Closer inspection reveals sparse foliage in the upper crown, stunted needles, reduced terminal shoot growth, and exudation of resin through the bark along the trunk, anywhere from the base of the tree well into the crown. The resin flow comes from lesions which may range in length from a few inches to several feet. The cambium beneath these lesions is dead.

Pole blight is being studied jointly by the University of Idaho School of Forestry; Division of Forest Pathology of the Bureau of Plant Industry, Soils, and Agricultural Engineering; Forest Insect Laboratory of the Bureau of Entomology and Plant Quarantine; and the Experiment Station. Research by these agencies includes: Studies of fungi and insects, root, stem, and foliar analyses of healthy and diseased trees, soil moisture and nutrient deficiencies, rate of spread, effect on the remaining stand caused by cutting diseased trees, and surveys to determine occurrence and extent of damage. Information on research plans and findings also are exchanged with Canadian forest pathologists who are studying pole blight in British Columbia.

Pole blight is particularly serious because it attacks an age class that is already scarce. Pole-size white pine is badly needed to fill the gap between the present old-growth timber and the reproduction and sapling stands. If pole blight continues to spread it could severely impede continued production of white pine. But when the cause is discovered, silvicultural or other measures may be devised which will either prevent the disease or lessen its harmful effects.

WHITE PINE BLISTER RUST
Area 65

White pine blister rust, a disease of Asiatic origin that attacks 5-needle pines, undoubtedly is the greatest obstacle to continued production of western white pine. Blister rust was first found on the Experimental Forest on its alternate host, ribes (currants and gooseberries) in the late 1920's. Infections on white pine trees on the Forest were discovered about 1935, and by 1940 pine infections had become common. Today, blister rust and requirements for its control must be considered in every management operation on the Experimental Forest.

Efforts to control blister rust were started before its entrance to the Experimental Forest. The first ribes eradication in the Inland Empire occurred on the Forest in 1923 when crews hand pulled ribes bushes on 155 acres along Benton Creek, under the direction of the Office of Blister Rust Control, Bureau of Plant Industry, U. S. Department of Agriculture. In 1934, the entire Experimental Forest was searched for ribes by CCC eradication crews. In 1937, part of the Forest was re-worked by emergency relief laborers. Additional eradication was performed in 1943, 1946, and 1947, chiefly along new roads, where ribes are likely to germinate and and grow vigorously.

Despite the eradication of many ribes, rust infection intensified during the "wave-year", 1941. Nevertheless, the earlier work probably has aided materially in reducing losses, especially from the dangerous stream-type ribes where some of the earlier control was more effective.

The white pine reproduction of Area 65 has suffered the greatest damage by rust of any stand on the Forest: About 50 percent of the white pine trees in this tract have killing infections. Second to it is the white pine stand of Area 27 which has incurred about 30 percent damage. The 90-year-old stands which cover much of the Experimental Forest have less than 10 percent killing infections. The Experimental Forest contrasts greatly with nearby tracts, unprotected by blister rust control, in which the white pines are riddled with rust. Damage to pine on the Forest is generally light to moderate.

The Experiment Station has cooperated with the Office of Blister Rust Control on a number of white pine blister rust studies and has encouraged use of the Experimental Forest for that purpose. The Office of Blister Rust Control has conducted several studies of ribes ecology on the Priest River Experimental Forest. Station Paper No. 3, prepared jointly by the Office of Blister Rust Control and the Station, summed up knowledge on blister rust control in the management of western white pine in 1940. An up-to-date report on the same subject will be released in 1951 by the same agencies.

Station Paper No. 16 describes an economic analysis of blister rust control and presents a blister rust control policy for national forests. Its conclusion is that control should be carried out on only those tracts which will yield the greatest amount of white pine timber for each dollar spent. The white pine timber lands of the Inland Empire have been analyzed on this basis and drainages have been selected where blister rust is to be controlled out of funds now available. These control units will be intensively managed to produce the greatest practicable volume of pine. The Priest River and Deception Creek Experimental Forests have been designated as first priority control units in order to protect the valuable studies in progress.

CANYON CREEK NATURAL AREA
Area 66

The Natural Area, a tract covering 1034 acres, has been reserved from timber cutting as a sample of virgin timber of the western white pine forest region for purposes of science and education.

The tract is in an upper altitudinal zone with rugged mountainous terrain, so dissected by streams and ridges that all major exposures are represented and slopes vary from moderately steep to very steep. Water from the Natural Area flows into four streams: Canyon Creek to the north, Benton Creek to the west, Big Creek to the south, and Tarlac Creek to the east. Two of these, Canyon Creek and Benton Creek, originate within its boundaries. Elevation ranges from 4150 feet at the point where Canyon Creek flows out of the tract to 5900 feet on the ridge at the extreme southeast corner.

Area by cover types and age classes

Cover type	Age class in 1934						
	1-40 Yrs.	41-80 Yrs.	81-120 Yrs.	121-160 Yrs.	161-200 Yrs.	200+ Yrs.	All age classes
	Acres						
Western white pine	3	63	12	34	54	147	313
Douglas-fir		6				8	14
Western larch--Douglas-fir		5				7	12
Western hemlock--grand fir		11			53	65	129
Western redcedar						9	9
Lodgepole pine		47					47
Engelmann spruce					8		8
Barren -- rock							56
Grass							23
Brush							2
Subalpine	2	9	25	98	287		421
Total	5	141	37	132	402	236	1,034

Other kinds of trees in the Natural Area, in addition to the species for which cover types are named, are alpine fir and whitebark pine, found chiefly in the subalpine type, and Oregon yew (Taxus brevifolia) in older stands in several of the types. Altogether, 11 species of coniferous or evergreen trees are represented.

The Natural Area is also rich in subordinate vegetation. Shrubs and herbs principally include twinflower, goldthread, clintonia, arnica, Oregon grape, goatbrush, false Solomon seal, violets, princess pine, huckleberries, vine maple, serviceberry, honeysuckle, wintergreen, foamflower, baneberry, fool's huckleberry, rose, mountain ash, trillium, devil's club, sedge, and grasses. Several kinds of ferns also are common.

The Natural Area is readily accessible by automobile. In addition, foot trails traverse the tract and provide opportunities for intimate viewing or study of practically primeval forest communities. A bird's-eye view may be obtained from Gisborne Mountain Lookout.

1922 BURN
Area 67

Only one forest fire has burned a substantial acreage on the Experimental Forest since it was established in 1911. Although many fires have started, they have been detected early and controlled rapidly. The main reason for the excellent fire control record is the effective protection provided by the Kaniksu National Forest organization.

The Highlanding Fire of August 1-4, 1922, burned 850 acres, including 400 acres within the Forest. The fire started in the southwest corner of the Experimental Forest from a campfire abandoned by picnickers. It spread to an area of piled slash, and from there sparks from burning snags blew across the county road. The fire raced over a cut-over area into the standing timber on Fox Creek and burned over the ridge into the Benton Creek drainage to the edge of two series of permanent sample plots and to within a few hundred feet of the headquarters buildings. Most of the burn occurred in a 65-year-old stand of white pine, western larch, and Douglas-fir. The larch survived, but most of the other trees were killed. In addition, the fire destroyed 1½ million board feet of mature timber within the Forest.

The following year a salvage operation removed the fire-killed timber. The slash was piled in windrows and burned in the fall of 1924. In April 1926, 44 acres were planted with 1-2 ponderosa pine stock at a rate of 1,070 trees per acre. At the end of the first growing season 738 trees per acre, or 69 percent, were alive. Third-year survival was 578 trees per acre, or 54 percent. On parts of the area the survival deviated considerably from these average percentages.

On a portion of the burned area near the Fox Creek saddle, dense brush, mostly ceanothus, covered about 75 percent of the area in 1935. The windrows where slash was burned, however, were still clear of brush in 1935, 10 years after burning. Data from a sample plot, No. 174, in this area showed that in 1935 practically all the 500 live trees per acre were situated in the burned windrows and other openings in the brush. Where shrubs had created continuous cover most of the planted trees had died. Shrubs harm small trees by shading them excessively, competing for soil moisture, and smothering them with fallen leaves. In addition, shrubs make habitats unfavorable for small trees by giving cover to snowshoe hares or rabbits. These animals, which prefer to live in dense shrubby cover, weaken or kill small conifers by nipping off the twigs. On another sample plot, where only 25 percent of the ground was covered with shrubs, 1,020 trees per acre, twice the number on the first plot, were alive in 1938. Little browsing had occurred on this plot because the sparse shrub cover was not attractive to rabbits.

LODGEPOLE PINE - JACK PINE HYBRID
(Plot 193)
Area 68

(Location, E4, not shown on map)

Area 68 contains an out-planting test of a lodgepole pine-jack pine hybrid developed by the Institute of Forest Genetics at Placerville, California, a branch of the California Forest and Range Experiment Station. The purposes of the experiment are to observe the qualities of the hybrid and to determine its suitability for growth in the northern Rocky Mountains and Inland Empire.

For comparative purposes, the test includes not only the hybrid but also lodgepole pine from the parent stock (California), jack pine from Minnesota, and two lots of lodgepole pine from Montana. The seeds from all sources were sown at Savenac Nursery, Montana, in the spring of 1948. The resulting seedlings were transplanted in the nursery a year later to induce stockier growth. They were planted on the Experimental Forest on May 18, 1950. Identical plots were planted at two locations in Montana the same spring. Each tree is marked with a numbered stake referring to the identification given below. The plot includes five trees of each of the following kinds arranged in a randomized block experimental design.

Species and source	Identification No.	Height Sept. 1950 (Feet)
Lodgepole pine (California) x jack pine (Wisconsin) hybrid	1	0.58
Lodgepole pine (California)	2	0.28
Jack pine (Minnesota)	3	0.76
Lodgepole pine (Moser Creek, Montana)	4	0.34
Lodgepole pine (Missoula, Montana)	5	0.32

Complete information on this test is posted in the bulletin board sign at the test site.

One of the objectives of hybridizing trees is to combine the better qualities of both parents. For example, jack pine grows faster than lodgepole pine but the latter excels in longevity, bole form, and limb habit. The hybrids on Area 68 are intermediate to their parents in appearance and height growth. Experiments at the California Station and elsewhere have shown that in some instances hybrid trees possess the quality of hybrid vigor, meaning that the progeny excels both of its parents in one or more characteristics, such as growth rate.

Currently, the Station is participating in several tree breeding projects. These include assisting the Office of Blister Rust Control and the California Forest and Range Experiment Station in an attempt to establish and propagate blister rust resistant white pine, field testing several kinds of hybrid pines for the California Station, and making new hybrids with jack pine pollen on indigenous lodgepole pine.